Hampshire Water Transfer and Water Recycling Project

6.2 Environmental Statement Vol II Appendix 11.2 Geotechnical and geo-environmental reports - 8 of 18 documents - Geotechnical and Geo-environmental Interpretative Report for Ground Investigation in Section K (Phase 2 and Phase 3B/3C) Addendum to Summary Report

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Figure 1.2	Section K (SE) Ground Investigation Locations with PSCs	27/11/2024	• Ground investigation locations added to Figure 1.2

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1 Introduction and Objectives

1.1 Proposed Development

Water for Life Hampshire (WfLH) is a programme being undertaken by Southern Water Services Limited (hereafter referred to as 'the Applicant') to address the sustainability objectives of reduced abstractions on Hampshire's two main rivers, the River Test and River Itchen, and to ensure a resilient water supply for the Applicant's customers during times of drought. The Hampshire Water Transfer and Water Recycling Project (HWTWRP) (hereafter referred to as the 'Proposed Development') is the Strategic Resource Option project being delivered as part of the WfLH programme (Southern Water, 2024). An overview of the Proposed Development, at the time of this report production, is provided in the Applicant's HWTWRP Technical Document Technology Guide (Southern Water, 2024).

1.2 Terms of Reference

Strategic Solutions Partner (SSP) has been instructed by the Applicant as part of the Proposed Development to produce a Geotechnical and Geo-environmental Interpretative Report for ground investigations (GIs) completed for the construction of the proposed underground pipeline. The Proposed Development has been divided into 12 Sections by the Applicant these are referred to as Sections A to M (excluding I).

1.3 Ground Investigation Programme

The GI for the Proposed Development is being completed using a phased approach as shown in **Table 1.1~~Table 1.1~~**. This document reports the findings of the GI works completed during Phase 2 and Phase 3B/3C within Section K only.

Table 1.1: Ground investigation programme

GI Phase	Description
Phase 0	This, with Phases 1 and 3A, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor), as specified by SSP (AECOM), primarily for the purpose of tunnel and shaft design (Sections B, C, D and M only) and comprised 11 boreholes.
Phase 1	This, with Phases 0 and 3A, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor), as specified by SSP (AECOM), primarily for the purpose of tunnel and shaft design (Sections B, C, D, L and M only) and comprised 35 exploratory hole locations.
Phase 2	This is part of a wider phased GI conducted along the route between February 2023 and July 2023 by SOCOTEC for Clancy (Principal Contractor), as specified by SSP, primarily for the purpose of investigating areas for non-pipeline infrastructure, trenchless crossings and potential sources of contamination (PSCs).
Phase 3A	This, with Phases 0 and 1, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor), as specified by SSP (AECOM), primarily for the purpose of tunnel and shaft design (Sections B, C, D, L and M only) and comprised 14 exploratory hole locations.
Phase 3B/3C	This, with several Phase 2 GI locations was completed between May 2023 and May 2024 by SOCOTEC for Clancy (Principal Contractor), as specified by SSP, primarily for the purpose of investigating areas for non-pipeline infrastructure, trenchless crossings, PSCs and the linear route.

1.4 Section K Ground Investigation Objectives

The Phase 2 and Phase 3B/3C Section K GI investigated the following:

- Trenchless crossing locations.
- Areas of potential sources of contaminant (PSCs) as identified within HWTWRP Geotechnical and Geo-Environmental Desk Study Version 4 (SSP, 2024).
- The proposed non-pipeline Break Pressure Tank K (BPT-K) Above Ground Plant (AGP) location.
- Geological conditions along the linear route, confirmed at regular intervals, to prove the geological conditions to comply with Eurocode 7: Part 2 (BSI, 2007) recommendations.

The GI works comprised the following:

- Three exploratory holes at proposed launch / reception pits for a trenchless crossing beneath the River Hamble (2K5500SR and 2K5501SR), and another at Wintershill Hall land (3K5606SA).
- Four exploratory holes at the location of a potentially infilled former pond (2K5502DS, 2K5503DS, 2K5534DS and 2K5535DS).
- Eleven locations associated with a proposed non-pipeline infrastructure BPT-K Site immediately northeast of Wintershill Hall (CPT and boreholes 3K5521CT, 3K5525DR, 3K5527DR, 3K5540CT and 3K5541CT), and BRE365 infiltration tests (3K7541IT to 3K7546IT inclusive).
- Ten additional locations to prove the geology along the linear route to comply with recommended ground investigation spacings laid out in Eurocode 7: Part 2, comprising 2 No. dynamic sampler borehole locations (3K5511DS and 3K5531DS) and 8 No. hand pits (3K5513HP, 3K5515HP, 3K5529HP, 3K5530HP, 3K5604HP, 3K5607HP, 3K5608HP and 3K5610HP).

Uncompleted GI Works

Other PSCs identified within a 50 m radius of the proposed Draft Order Limits (DoL) of Section K have not been investigated during Phase 3B/3C, as agreed by the Applicant. These included farms, a former railway line and marshland. For these areas, it was considered that the potential for the presence of significant contamination is not high as defined in the Methodology for Identification of Ground Investigation (SSP, 2022b).

Ten further exploratory hole locations comprising 9 No. hand pits and 1 No. borehole were not completed due to land access issues (3K5507HP, 3K5508HP, 3K5509HP, 3K5519HP, 3K5532HP, 3K5600HP, 3K5601HP, 3K5602HP, and 3K5603HP and 3K5605SA). 3K5606SA is at a trenchless crossing launch / reception pit location originally paired with 3K5605SA, and located approximately 15 m southeast of Wintershill, but 3K5605SA was cancelled due to land access issues, timing of proposed drilling and the Applicant decisions.

Exploratory holes 3K5520CT and 3K5524CT were cancelled as there were issues with Site slopes along this section of the route. 3K5540CT at the top of the field, 3K5540CT at the base of field, and 3K5521CT were installed to represent this area.

1.5 Report Format

This report comprises both geotechnical and geo-environmental interpretation of data collated during the GI as outlined below:

Section 1 Introduction and report objectives.

Section 2 Description including the location and Site description.

Section 3 Summary of Ground Investigation

Section 4 Ground Model.

Section 5 GI results, data interpretation and geo-environmental risk assessment, and geo-environmental considerations for the outline proposed works.

Section 6 Development of the land contamination risk assessment model from the GI.

Section 7 Geotechnical Testing and Assessment including geotechnical summary tables and figures and design parameters.

Section 8 Geotechnical Considerations including hazard and mitigation table, discussions on ground conditions, foundation design, excavations, groundwater control, flotation, trenchless construction and concrete aggressivity.

Section 9 Conclusions

Section 10 Recommendations based on the results of the GI.

This report provides a summary of encountered ground conditions, existing GI results, geotechnical and geo-environmental interpretation of analysis undertaken to inform on potential future structures and route design, health and safety of construction and future ground workers (construction), and excavated materials (waste) management.

A land contamination risk assessment for other potential future receptors such as farmers/ farm workers / members of the public accessing and working within the Proposed Development is outside the scope of this report. Further ground investigation and human health risk assessment may be required to determine the risk to these and any other identified potential future receptors, particularly in regard to appropriate excavated materials management (e.g. proposed reuse of soils).

Assessment of the GI data collected across the other Proposed Development sections is included in separate relevant section reports, collated in the HWTWRP Geotechnical and Geo-environmental Interpretative Summary Report (Ref. 710166-SWS-XX-XX-RP-GE-00100).

2 Section K Description

2.1 Location and Description

Section K is shown in the **Figures** section of this report. The approximate 5.1 km length of Section K will consist of a 1200 mm diameter ductile iron (DI) pipeline in open-cut trenches between 3 – 6 m below ground level (bgl) and trenchless crossings across predominantly arable fields, illustrated in the **Figures** Section. The route starts at Botley Road (B3035) at a trenchless crossing expected to be between 9.7 m and 15 m bgl under the River Hamble then as open cut construction until Wintershill. Beneath Wintershill and Wintershill Hall estate land it is a trenchless crossing at approximately 6 m and 8 m bgl. The route continues as open-cut construction across Scivier's Lane, Alma Lane and Mortimers Lane (B3037), then joining with Section L to the east of Hawthorns Farm.

Section K starts at an elevation of approximately 23 m Ordnance Datum (OD) at Botley Road (National Grid Reference (NGR) 453970E, 115659N) and ends east of Hawthorns Farm (451922E, 119543N) at an elevation of approximately 46 m OD. The maximum elevation along Section K is approximately 75 m OD at Wintershill (NGR 452801E, 118518N).

Temporary launch and reception pits / shafts will be excavated; launch shaft dimensions will range between 9.0 m and 9.5 m diameter and reception shafts range between 5.0 m and 5.4 m diameter.

2.2 Above Ground Plant

Section K includes a proposed Break Pressure Tank – K (BPT-K) Above Ground Plant (AGP) Site within a field, approximately 20 m northeast of Wintershill Hall (452764E, 118429N). The proposed area for the AGP is approximately 80 m x 70 m and slopes down towards the northeast. At Wintershill Hall, elevations are approximately 76 – 77 m, decreasing to approximately 65 m OD. Preliminary dimensions of BPT-K and ancillary structures are as follows:

- BPT-K is split into two cells each of 15 m width x 20 m length x 4 m height. The base of the tank is 70 m OD.
- Access roads to the Site will be 6 m wide with a turning head assumed to be 20 m.
- Valve house with approximate dimensions 10.2 m length x 11.5 m width x 3.5 m height.

3 Phase 2 & Phase 3B/3C Ground Investigation

3.1 Rationale for Ground Investigation Locations

Phase 2 GI focussed on locations of critical infrastructure, trenchless crossings and areas of potential sources of contamination (PSCs) as identified within HWTWRP Geotechnical and Geo-Environmental Desk Study Version 4 (SSP, 2024). Phase 3B/3C investigations were completed to investigate PSCs, the linear route and for geotechnical testing to be undertaken. Further detail on the rationale for the Phase 2 and Phase 3B/3C GI is presented in **Table 3.1**.

Table 3.1: Rationale for Phase 2 & Phase 3B/3C Locations in Section K

Hole ID	Rationale for GI Location [1]
2K5500SR	To investigate excavation areas for trenchless crossing (Botley Road B3035 and River Hamble) and 65 m south of PSCs 121,122, and 123 (Infilled – Land – Channels).
2K5501SR	To investigate excavation areas for trenchless crossing (Botley Road B3035 and River Hamble) and PSC 119 (Infilled Land – Channel).
3K5511DS	To obtain information on the geology along the linear route to comply with Eurocode 7: Part 2 recommendations and to investigate PSC 530 – Worked Ground – Unspecified.
3K5604HP	To obtain information on the geology along the linear route to comply with Eurocode 7: Part 2 recommendations
3K5513HP	
3K5606SA	
3K5515HP	
3K5607HP	
3K5608HP	
3K7541IT – 3K7546IT (inclusive)	To complete BRE365 infiltration tests at the location of BPT-K.
3K5521CT	To gain information on ground and groundwater conditions at the location of BPT-K and nearby PSC 474 (Military – Wintershill Hall (former military / civilian base)), approximately 35 m south.
3K5540CT	
3K5541CT	
3K5525DR	
3K5527DR	
3K5529HP	To obtain information on the geology along the linear route to comply with Eurocode 7: Part 2 recommendations.
3K5530HP	
3K5609HP	
3K5531DS	
3K5610HP	
2K5502DS and 2K5503DS	To investigate PSC 132 (Infilled Land – Pond).
2K5534DS and 2K5535DS	

[1] PSCs within a 50 m buffer of the Section K DoL were identified by the desk study which warranted further investigation (SSP, 2023).

3.2 Section K Ground Investigations

GI was carried out at selected locations across Section K by SOCOTEC, between 1st March 2023 and 3rd May 2023. The GI scope was specified by SSP (SSP, 2022).

The following exploratory holes were completed during the Phase 2 GI:

- Two boreholes (2K5500SR and 2K5501SR) were completed by cable percussion boring extended by rotary core drilling to a depth of 20.2 m and 20.0 m bgl respectively.
- Exploratory holes 2K5502DS and 2K5503DS were scheduled to be dynamic sampler boreholes to 6.0 m bgl. However, these exploratory holes were completed as hand dug inspection pits instead to a maximum depth of 0.9 m due to multiple water strikes, pit collapse and soft ground conditions. As a deviation to the scope of works, two further attempts were made to drill to depth in proximity to these locations (2K5534DS and 2K5535DS), however these were also completed as inspection pits due to the same challenging ground conditions.

The following exploratory holes were completed during the Phase 3B/3C GI between 25th October 2023 and 7th May 2024 (SSP, 2023c), (SSP, 2023d):

- Three boreholes (3K5521CT, 3K5540CT and 3K5541CT) were completed by cone penetration testing (CPTs) to a drilled depth of between 3.93 m and 10.00 m bgl. The scheduled depth was 10 m bgl, however only 3.93 m bgl was achieved at 3K5541CT due to CPT rig instability at the hole location. The instability was caused when the vertical CPT rod alignment became bent beyond the tolerance threshold (deflection angle), leading to CPT tool refusal.
- Two dynamic sampler borehole locations (3K5511DS and 3K5531DS) were completed to 6.0 m bgl.
- Two boreholes (3K5525DR and 3K5527DR) were completed by dynamic sampling with rotary coring to depths between 8.0 m and 30.0 m bgl.
- Eight hand dug trial pits (3K5513HP, 3K5515HP, 3K5529HP, 3K5530HP, 3K5604HP, 3K5607HP, 3K5608HP and 3K5610HP) were completed to 1.2 m bgl.
- One borehole (3K5606SA) was completed by cable percussion boring to a depth of 20.45 m bgl.
- Six machine excavated trial pits (3K7541IT to 3K7546IT inclusive) were completed to a depth of 2.5 m bgl.

A plan showing the exploratory hole locations is presented in the **Figures** section. The scope of the GI also included: in-situ geotechnical tests, volatile headspace testing by Photo-ionisation Detector (PID), a falling head permeability test (2K5501SR), geotechnical and geo-environmental sampling, and follow-up groundwater and gas monitoring.

The details of the GI, tests and laboratory analysis are presented in the SOCOTEC Ground Investigation Final Factual report (SOCOTEC, 2023) (SOCOTEC, 2024). A description of GI locations is shown in **Table 3.2**.

Table 3.2: Description of GI Locations

GI Locations	National Grid Reference [1]	Location Description
2K5500SR	453871, 115639	Located within a field, approximately 10 m south of the Botley Road (B3035), approximately 1.7 km northeast of Curdridge village, Hampshire. River Hamble is located approximately 150 m north. A tributary to the River Hamble is located approximately 15 m southwest. The surrounding land use is rural.
2K5501SR	453899, 115871	Located within a field, approximately 180 m northeast of the Botley Road (B3035), approximately 1.8 km northeast of Curdridge village. River Hamble is located approximately 65 m south. A tributary to the River Hamble is located approximately 45 m west. A field drain may have been present within 10 m of the GI location. The surrounding land use is rural.
3K5511DS	453480, 117568	Located within a field, 5 m southwest of a track that extends approximately 430 m southwest of Wintershill.
3K5604HP	453275, 117637	Located in a field, approximately 280 m southeast of Wintershill.
3K5513HP	453046, 117766	Located within a field, approximately 80 m southwest of Wintershill.
3K5606SA	452978, 117981	Located in a field, approximately 480 m southeast of Wintershill Hall and 150 m northwest of Wintershill.
3K5515HP	452943, 118254	Located approximately 200 m southeast of Wintershill Hall, and approximately 200 m southwest of a track leading to Wintershill Hall.
3K5607HP	452945, 118490	Located in a field approximately 180 m northeast of Wintershill Hall.
3K5608HP	452852, 118630	Located in a field approximately 210 m northeast of Wintershill Hall.
3K7541IT	452792, 118483	Located in a field approximately 55 m northeast of Wintershill Hall.
3K7542IT	452816, 118500	Located in a field approximately 80 m northeast of Wintershill Hall.
3K7543IT	452808, 118512	Located in a field approximately 90 m northeast of Wintershill Hall.
3K7544IT	452770, 118474	Located in a field approximately 40 m northeast of Wintershill Hall.
3K7545IT	452757, 118596	Located in a field approximately 70 m northeast of Wintershill Hall.
3K7546IT	452770, 118531	Located in a field approximately 95 m northeast of Wintershill Hall.
3K5521CT	452798, 118518	Located approximately 95 m northeast of Wintershill Hall,
3K5540CT	452834, 118500	Located within a field approximately 95 m northeast of Wintershill Hall.
3K5541CT	452772, 118466	Located within a field approximately 35 m northeast of Wintershill Hall.
3K5525DR	452794, 118471	Located approximately 55 m northeast of Wintershill Hall.
3K5527DR	452779, 118529	Located approximately 100 m northeast of Wintershill Hall.
3K5529HP	452779, 118529	Located within a field approximately 230 m east of Sciviers Lane.
3K5530HP	452457, 118899	Located within a field approximately 130 m northeast of Sciviers Lane.
3K5609HP	452380, 118977	Located within a field approximately 140 m west of Sciviers Lane.
3K5531DS	452356, 119091	Located within a field approximately 75 m east of Sciviers Lane.
3K5610HP	452272, 119130	Located within a field approximately 10 m northwest of Sciviers Lane.
2K5502DS	452139, 119217	Located within a field adjacent to a watercourse, approximately 60 m southeast of Alma Lane, approximately 350 m south of Lower Upham village, Hampshire. The watercourse is a tributary to Ford Lake. The surrounding land use is rural.
2K5503DS	452127, 119223	
2K5534DS	452144, 119218	
2K5535DS	452151, 119213	

[1] provided in the Final factual GI report (SOCOTEC, 2023) (SOCOTEC, 2024).

3.3 Exploratory Holes and Monitoring Well Installations

The exploratory hole locations and borehole logs are presented in SOCOTEC's Ground Investigation Reports (SOCOTEC, 2023) (SOCOTEC, 2024). **Table 3.3** provides a summary of the installation response zones and the number of monitoring visits completed. A plan showing the exploratory hole locations is presented in the **Figures** section.

Groundwater / gas monitoring wells were installed in 2K5500SR (50 mm pipe diameter) and 2K5501SR (19 mm pipe diameter). A datalogger was installed in monitoring well 2K5500SR at 4.8 m bgl on 19th June 2023, during the second groundwater monitoring event.

Groundwater / gas monitoring wells were installed in 3K5525DR and 3K5606SA (50 mm pipe diameter).

Table 3.3: Summary of Groundwater and Ground Gas Monitoring

BH ID	Response Zones (m bgl)	Groundwater Level Monitoring Rounds	Gas Monitoring Rounds	Groundwater Samples Collected
2K5500SR	3.0 m to 7.0 m (River Terrace Deposits and London Clay)	13 No. (24/05/23 to 04/04/24)	12 No.	4 No. 16/05/23 18/07/23 12/09/23 30/07/24
2K5501SR	1.0 m to 2.0 m (Head Deposits)	14 No. (26/04/23 to 09/04/24*)	09/04/24 (no gas tap installed previous to this event)	2 No. 11/05/23 24/07/23
3K5525DR	0.75 to 5.25 m (Alluvium and London Clay Formation)	7 No. (30/11/23 to 09/04/24)	7 No. (30/11/23 to 09/04/24)	3 No. 30/11/23 10/01/24 08/03/24
3K5606SA	6.0 to 10.0 m (London Clay Formation)	7 No. (30/11/23 to 09/04/24)	7 No. (30/11/23 to 09/04/24)	3 No. 30/11/23 10/01/24 08/03/24

*For 2K5501SR no monitoring conducted on 10th October 2023 due to landowner restrictions.

3.4 Geo-Environmental Testing

Geo-environmental laboratory testing was scheduled by SSP on selected soil and groundwater samples recovered during the GI works. The testing was carried out by SOCOTEC at their UKAS-accredited environmental chemistry laboratory at Bretby, near Burton-on-Trent, in accordance with MCERTS accredited (where applicable) test methods as stated within the laboratory test reports. The scope of testing is listed in **Appendix B**. **Appendix B** shows that several requested chemical analyses was not included in either AGS format or Final Factual GI reports (SOCOTEC, 2023) (SOCOTEC, 2024).

3.5 Geotechnical Testing

Geotechnical testing was scheduled by SSP on selected soil samples recovered during the GI works. The testing was carried out by nominated UKAS-accredited geotechnical laboratories including: GEOLABS, near Watford, The Testing Lab (TTL) near Doncaster and Derwentside Environmental Testing Services Ltd (DETS) near Durham. Depending on the samples available, the testing comprised a combination of moisture content, Atterberg limits, density (linear), particle size distribution, saturation moisture content (chalk), unconfined compression strength, point load index testing, unconsolidated undrained triaxial, compaction, chalk crushing value, chalk carbonate content, BRE testing, organic matter content and loss on ignition. The tests completed are presented in the SOCOTEC final factual report (SOCOTEC, 2023) (SOCOTEC, 2024).

4 Ground Model

4.1 Geological Setting

Superficial deposits are absent for the majority of Section K, except southwest of Bishops Waltham near the River Hamble (Alluvium, Head Deposits and River Terrace Deposits), and near watercourses to the east and southeast of Wintershill (Alluvium); all of which are underlain by London Clay bedrock. Lambeth Group and White Chalk Subgroup would be at greater depth. Superficial Deposits extent is summarised in **Table 4.1.**

Table 4.1: Summary of Mapped Superficial Deposits at Ground Level

Chainages	Geology	Typical Description
24800 – 24900	Not present	-
24900 - 24960	Alluvium	Clay, silt and sand, locally organic with gravel.
24960 - 25130	Head Deposits	Variable deposits of sandy silty clay, locally gravelly; chalky and flinty in dry valleys.
25130 - 25160	River Terrace Deposits	Undifferentiated sand and gravel.
25160 - 25760	Not present	-
25760 - 25820	Head Deposits	Variable deposits of sandy silty clay, locally gravelly; chalky and flinty in dry valleys.
25820 - 26940	Not present	-
26940 - 26960	Alluvium	Clay, silt and sand, locally organic with gravel.
26960 - 29930	Not present	-

The chainages have been provided by the Applicant as of 12 March 2024 as part of the Summer 2024 Design Consultation Route.

Section K is underlain by London Clay Formation, with the bedrock extent is summarised in **Table 4.2.**

Table 4.2: Summary of Mapped Bedrock at Ground Level

Chainages	Geology	Typical Description
24800 - 29930	London Clay Formation	Grey and brown silty and sandy clays with sandy and pebbly beds.

The chainages have been provided by the Applicant as of 12 March 2024 as part of the Summer 2024 Design Consultation Route.

Two historic boreholes were drilled for water supply in the vicinity of Section K between years 1891 and 2000. These progressed to greater depths than the proposed works. Both boreholes encountered London Clay Formation to greater than 32 m bgl. The borehole logs generally agreed with the geological sequence anticipated from the geological mapping. A disturbed mixture of chalk and Reading Formation (the latter part of the Lambeth Group) was identified in one of the boreholes (SU51NW2), which appears to be a local feature - the borehole was thought to have been drilled into a sub-Tertiary chalk dissolution pipe (previously unknown about in 1891).

Further details, including available, archive borehole logs can be viewed with the HWTWRP Geotechnical and Geo-Environmental Desk Study Version 3 (SSP, 2023) and the GI factual reports produced by SOCOTEC (SOCOTEC, 2023) (SOCOTEC, 2024).

4.2 Ground Investigation Results

4.2.1 Encountered Ground

A brief summary of the ground conditions encountered during the ground investigation is provided in **Table 4.3,** which mostly correlate with the geological mapping. Exploratory hole logs are presented in SOCOTEC's Ground Investigation Reports (SOCOTEC, 2023) (SOCOTEC, 2024) to provide more details.

Chainages across the route for Section K are between 24750 and 29930 as shown in **Table 4.3**.

Superficial deposits including Alluvium, Head Deposits and River Terrace Deposits are not mapped where the exploratory holes are located. However, superficial deposits that are expected with less than a 1 – 2 m thickness are not always shown on geological maps.

The encountered ground matches the BGS boreholes summarised in the desk study to the top 1 m bgl within boreholes 2K5502DS, 2K5503DS, 2K5534DS and 2K5535DS before these locations were terminated earlier than scheduled depth due to water ingress within the inspection pits.

The desk study did not list a likelihood of Made Ground within Section K however, it is expected that some would be encountered near agricultural or suburban areas along the route.

At 3K5525DR, between 24.15 – 24.90 m bgl, silty sand is described, which may be associated with London Clay Division C (Portsmouth Sand Member) as encountered within Section J.

Table 4.3: Summary of Encountered Ground Conditions for Section K Exploratory Holes

Exploratory Hole ID:		2K5500SR	2K5501SR	2K5502DS	2K5503DS	2K5534DS	2K5535DS	3K5511DS	3K5513HP	3K5515HP	3K5525DR	3K5527DR	3K5529HP	3K5530HP	3K5531DS
Ground Level (m OD)		+23.16	+17.75	+43.83	+43.73	+43.81	+43.99	+36.00	+49.19	+56.02	+ 72.19	+67.23	+52.18	+49.20	+44.81
Chainage (m)		24750	24985	29500	29520	29520	29520	27970	27460	27980	28500	28500	28870	29020	29240
Strata	Typical Description	Depth range (m bgl)													
Topsoil	Grass over gravely sandy CLAY/SILT	-	0.00 – 0.12	0.00 – 0.15	0.00 – 0.18	0.00 – 0.17	0.00 – 0.15		0.00 – 0.20	0.00 – 0.30	0.00 – 0.20	0.00 – 0.15	0.00 – 0.30	0.00 - 0.30	0.00 - 0.15
Made Ground	Soft brown sandy gravelly CLAY. Gravel is chert, brick, (burnt wood at 3K5511DS), macadam (2K5500SR only). Sand is fine to coarse.	0.00 – 0.70	-	0.15 – 0.60	-	-	-	0 – 1.60	-	-	-	-	-	-	-
Alluvium	Soft and firm grey mottled black sandy SILT with organic odour (2K5502DS only). Sand is fine / Orange/brown sandy gravelly CLAY	-	-	0.60 – 0.70	0.18 – 0.90	0.17 – 0.70	0.15 – 0.70	-	-	-	0.20 – 3.00	0.15 – 2.50	-	-	-
Head Deposits	Firm orangish brown mottled grey sandy cobbly CLAY. Cobbles are of flint. / Grey sandy clayey GRAVEL of flint / Firm orangish brown mottled grey sandy CLAY.	-	0.12 – 2.00	-	-	-	-	-	-	0.30 – 0.70	-	-	0.30 -1.20	-	-
River Terrace Deposits	Soft greyish brown slightly sandy gravelly CLAY. Gravel is flint and chalk.	0.70 – 4.90	-	-	-	-	-	-	-	-	-	-	-	-	-
London Clay Formation	Firm to stiff becoming very stiff locally fissured slightly sandy silty CLAY with shell fragments (<25 mm diameter) and pyrite nodules (25 – 50 mm diameter). Locally soft to firm near the top of the stratum. At 3K5525DR, from 6.6-6.75 m, 1 cobble of strong limestone. At 2K5500SR, very stiff from 6.50 – 20.20 m For 2K5501SR, at 9.70 - 9.80 m, fine to coarse medium strong claystone. For 2K5501SR, from 16.70-16.80 m, strong dark greyish brown argillaceous fine to medium grained fossiliferous limestone with calcite voids. At 3K5525DR, at 24.1m, 1 No. well rounded fine gravel of claystone. from 24.15-24.90m, silty fine sand.	4.90 – 20.20	2.00 – 20.00	-	-	-	-	1.6 – 6.45	0.20 – 1.20	0.70 – 1.20	3.00 – 30.50	2.50 – 8.45		0.30 -1.20	0.15 – 6.00
Base of Hole (m bgl)		20.20	20.00	0.70	0.90	0.70	0.70	6.45	1.20	1.20	30.50	8.45	1.20	6.45	1.20

Exploratory Hole ID:		3K5604HP	3K5606SA	3K5607HP	3K5608HP	3K5609HP	3K5610HP	3K7541IT	3K7542IT	3K7543IT	3K7544IT	3K7545IT	3K7546IT
Ground Level (m OD)		+45.95	+45.16	+57.07	+52.03	+45.27	+45.18	+71.56	+66.38	+65.94	+74.65	+72.71	+67.70
Chainage (m)		27180	27700	28220	28370	29130	29350	28500	28500	28500	28500	28500	28500
Strata	Typical Description	Depth range (m bgl)											
Topsoil	Grass over gravely sandy CLAY	0.00 – 0.30	0.00 – 0.15	0.00 – 0.30	0.00 – 0.35	0.00 - 0.30	0.00 -0.30	0.00 – 0.25	0.00 – 0.20	0.0 0.30	0.00 – 0.25	0.00 – 0.25	0.00 - 0.30
Made Ground	Soft brown/orange sandy slightly gravelly CLAY. Gravel is chert, brick, tile, chalk, macadam (top 0.3 m at 2K5500SR). Sand is fine to medium.	-	-	-	-	-	-	-	0.20 – 0.55	-	-		
Alluvium	Soft grey mottled black sandy SILT with organic odour (2K5502DS only). Sand is fine / Orange/brown sandy gravelly CLAY	-	0. 15 – 2.00	-	-	-	-	-	0.55 – 1.20	0.30 – 0.75	-	0.25 – 1.45	0.30 – 1.30
Head Deposits	Firm orangish brown mottled grey sandy / gravelly / cobbly CLAY. Cobbles are of flint. / Grey sandy clayey GRAVEL of flint / Firm orangish brown mottled grey sandy CLAY.	-	-	0.30 – 0.80	0.35 – 1.20		0.30 - 0.90	0.25 – 0.90	-	-	0.25 – 0.70	-	-
London Clay Formation	Firm to stiff becoming very stiff locally fissured slightly sandy silty CLAY with shell fragments (<25 mm diameter) and pyrite nodules (25 – 50 mm diameter). Locally soft to firm near the top of the stratum. At 3K5525DR, from 6.6-6.75 m, 1 cobble of strong limestone. For 2K5500SR, very stiff from 6.50 – 20.20 m For 2K5501SR, at 9.70 - 9.80 m, fine to coarse medium strong claystone. For 2K5501SR, from 16.70-16.80 m, strong dark greyish brown argillaceous fine to medium grained fossiliferous limestone with calcite voids. At 3K5525DR, at 24.1m, 1 No. well rounded fine gravel of claystone. from 24.15-24.90m, silty fine sand.	0.30 – 1.20	2.00 – 20.45	0.75 – 1.20	-	0.30 – 1.20	0.90 – 1.20	0.90 – 2.50	1.20 – 2.50	0.75 – 2.50	0.70 – 2.50	1.45 – 2.50	1.30 – 2.50
Base of Hole (m bgl)		1.20	20.45	1.20	1.20	1.20	1.20	2.50	2.50	2.50	2.50	2.50	2.50

4.2.2 Groundwater Levels

Groundwater and ground gas monitoring took place in selected boreholes specified by SSP. Monitoring was carried out by SOCOTEC during and after the main fieldwork period. A summary of groundwater and ground gas monitoring installations is provided in **Table 4.4** along with the groundwater strikes, and groundwater spot monitoring data collected at monitoring well locations.

Table 4.4: Summary of Groundwater Strikes and Spot Monitoring Records

Exploratory Hole	Response zone (m bgl)	Strike During Drilling – Depth and Elevation	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation	Data Logger – Minimum/ Maximum Depth
2K5500SR	3.0-7.0 (River Terrace Deposits and London Clay Formation)	6.10 m bgl (17.05 m Ordnance Datum (OD) rose to 6.30 m (16.86 m OD)	London Clay Formation	2.28 m to 2.97 m bgl (20.98 m to 20.19 m OD)	1.37 m to 2.5 m bgl 21.79 m to 20.66 m OD
2K5501SR	1.0-2.0 (Head deposits)	No Strike	N/A	0.00 m* to 0.95 m (17.75 m to 16.80 m OD)	None
2K5502DS	No Installation	0.7 m bgl (43.13 m OD) rose to 0.5 m after 20 mins (43.33 m OD)	Made Ground/Alluvium	N/A	
2K5503DS		0.9 m bgl (42.83 m OD) Rose to 0.8 m after 20 mins (42.93 m OD)	Alluvium		
2K5534DS		No Strike	N/A		
2K5535DS		0.7 m bgl (43.28 m OD) rose to 0.5 m (43.49 m OD)	Alluvium		
3K5513HP		1.20 m (47.99 m OD) Seepage slow inflow	London Clay Formation		
3K5515HP		0.70 m (55.32 m OD)	Head Deposits/ London Clay Formation		
3K5525DR	0.75 to 5.25 m (Alluvium and London Clay Formation)	No Strike	N/A	1.09 m to 1.78 m (41.10 m to 40.41 m OD)	
3K5529HP	No Installation	1.20 m (50.98 m OD) Seepage	London Clay Formation	N/A	
3K5606SA	6.0-10.0 (London Clay Formation)	No strike	N/A	1.17 m to 1.99 m bgl (43.99 to 43.17 m OD)	
3K5608HP	No Installation	0.90 m (51.13 m OD)	Head Deposits	N/A	

* 2K5501SR was flooded on 26/04/23 and a groundwater level reading was recorded at 0.00 m bgl on 19/06/23.

The ground conditions and groundwater results are mostly consistent with the anticipated ground conditions from the desk study and BGS boreholes. Superficial Deposits comprise predominantly Head Deposits with Alluvium, which are probably more extensive than mapped. The outlier is the description of soft clay within the

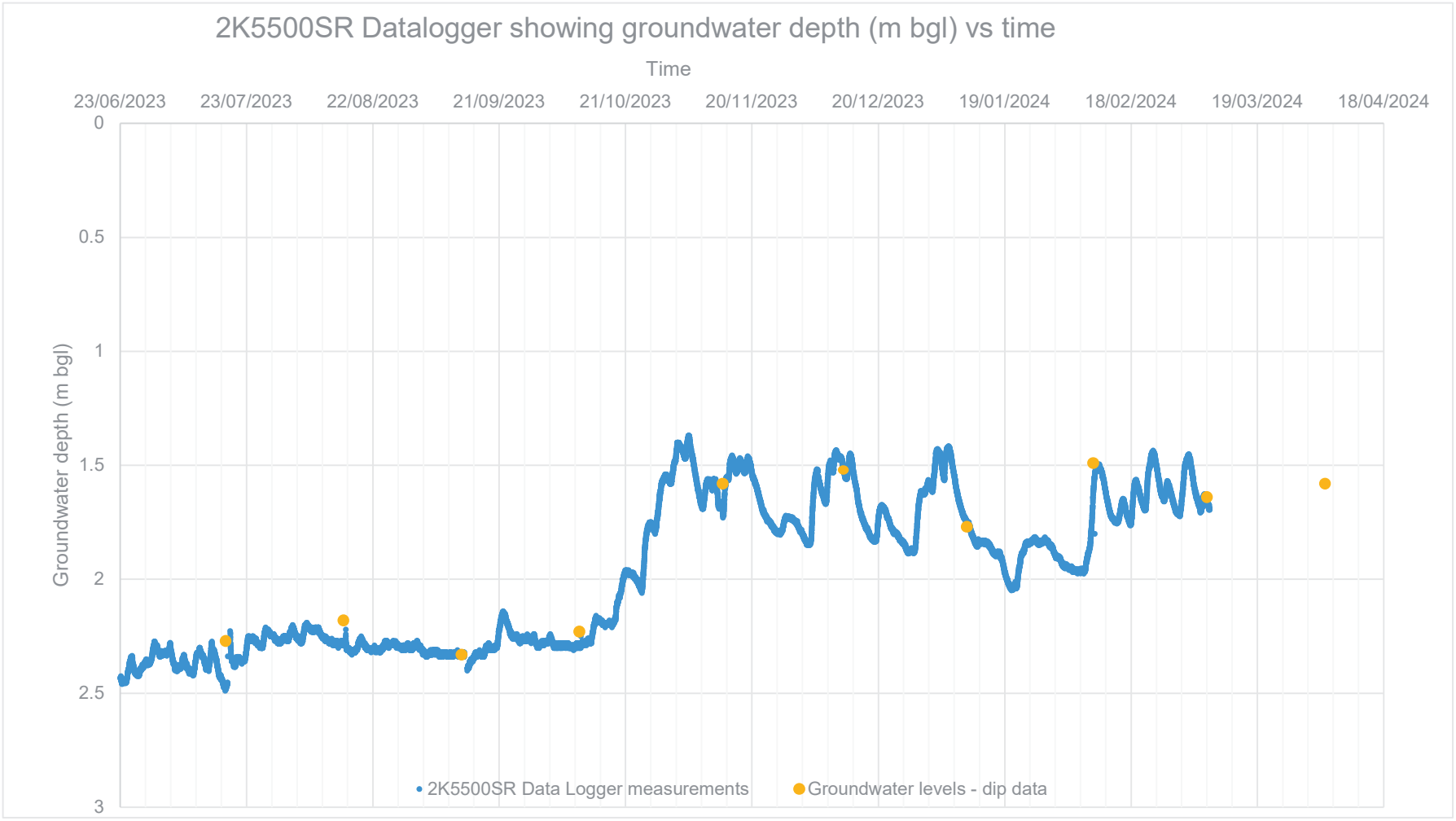
River Terrace Deposits, which potentially could be Alluvium as both deposits were geologically mapped at the same location (at 1:50,000 scale). River Terrace Deposits do contain lenses of clay.

Graph 4.1 shows the groundwater levels for 2K5500SR near the proposed trenchless crossing of the River Hamble – this was monitored by downhole dataloggers placed 1m above the base of the slotted pipe. Data from March 2024 onwards will be provided to the Applicant separately as soon as the borehole has been decommissioned.

4.2.3 Visual and/or Olfactory Contamination

No visual and/or olfactory evidence of contamination recorded on the exploratory hole logs.

Graph 4.1 (extract): Datalogger groundwater levels for 2K5500SR between June 2023 and March 2024



5 Generic Quantitative Risk Assessment (GQRA)

This report section assesses the soil, soil leachate, groundwater and gas data collected within the DoL for Section K only.

In accordance with the guidance given in 'Land Contamination Risk Management' (LCRM) (Environment Agency, 2023) the results of the geo-environmental laboratory testing undertaken on the samples of soil and groundwater recovered during the 2023 and 2024 SOCOTEC GI have been compared to current published generic assessment criteria (GAC) to identify potential hazards to the plausible receptors.

The 6 No. soil samples from Phase 2 GI locations included 1 No. sample of topsoil, 1 No. soil sample of Made Ground, and 4 No. of natural ground (River Terrace Deposits, Head Deposits and London Clay).

The 36 No. soil samples from Phase 3B/3C GI locations included 8 No. soil samples of topsoil, 3 No. soil samples of Made Ground, and 25 No. of natural ground (London Clay, Head Deposits and Alluvium).

5.1 Soil Results

5.1.1 Assessment of Potential Risk to Human Health Receptors

There were no recorded exceedances of the human health GAC (commercial land use) for 2K5500SR, 2K5501SR, and all phase 3B/3C exploratory holes. Details of the GAC used for screening are provided in **Appendix G**.

Asbestos cement (Chrysotile) was detected in soil sample 2K5500SR at 0.5 m bgl; details are included in **Table 5.1**. There was no other identified asbestos in soil samples tested.

5.1.2 Notable Soil Contaminant Concentrations

GAC are not available for all determinands analysed. Concentrations which appear to be elevated compared to other chemical results recorded during the GI are included in **Table 5.1.**

Table 5.1: Notable Contaminant Soil Concentrations

Exploratory Hole ID	Depth (m bgl)	Determinand	Concentration (mg/kg)
2K5500SR	0.5 Made Ground	Asbestos	**0.147% Chrysotile (asbestos cement)**
	4.5 River Terrace Deposits	Lead	**124**
		Mineral oil >C_6-C_{40}	**101**
3K5515DS	0.2 Topsoil	TPH >C_{10}-C_{40}	**534**
3K5606SA	0.5 Alluvium	Copper	**566**

5.1.3 Soil Sample Deviations

Soil sample deviations were recorded for samples stated in **Appendix C**. This was due to the acceptable (holding) time between the sampling date and laboratory analysis being exceeded[1].

5.2 Soil Leachate and Groundwater Results

Soil leachate and groundwater concentrations have been compared to the Drinking Water Inspectorate Drinking Water Standard (DWS) guidance (Drinking Water Inspectorate, 2024) and the withdrawn Water Supply (Water Quality) Regulations 1989 (WQS) for petroleum hydrocarbons (Legislation.gov.uk, 2024)

5.2.1 Comparison of Soil Leachate Results Against GAC

Of the six-soil leachate tests (2:1 ratio) requested from Phase 2 GI soil samples, only one result has been reported, 2K5501SR at 6.0 m bgl (London Clay). Comparison of the results for this sample against the GAC recorded an ammonium (NH_4) concentration of 692.8 µg/l which exceeded the UK Drinking Water Standard (DWS) of 500 µg/l.

The results of the chemical analysis for soil leachate samples 2K5500SR at 0.5 m, 2K5500SR at 1.0 m, 2K5501SR at 1.0 m, 2K5503DS at 0.1 m and 2K5503DS at 1.0 m are not included in the SOCOTEC final report or in accompanying AGS data format. No leachate results were obtained for 3K5511DS due to an insufficient sample volume available.

The Total Ammonia (N) concentration at 601 µg/l for 2K5501SR at 6.0m bgl exceeds the Water Framework Directive (WFD) for ammonia GAC of 200-600 µg/l. This exceedance is not considered significant because the concentration detected is only 1 µg/l above the GAC and the laboratory margin of error on analysis is likely be greater than 1 µg/l. No other exceedances were detected. Further details on the selection of GAC protective of aquatic ecosystems (controlled waters) are provided in **Appendix G.**

Potential contaminants for which the Method Detection Limit (MDL) exceeded the corresponding GAC are presented in **Appendix C**. Testing with an MDL lower than the EQS for the PAHs listed is typically not offered by standard commercial laboratories. It is noted that the analytical laboratory reported a TPH concentration of <314 µg/l. This result is greater than the MDL (110 µg/l). The laboratory advised that a reduced volume could only be leached from the soil sample; therefore, the MDL has been raised.

5.2.2 Comparisons of Groundwater Results Against GAC

Contaminant concentrations in excess of the GAC for the 13 No. groundwater samples collected from Phase 2 and Phase 3B/3C are shown in **Table 5.2** and **Table 5.3**.

[1] Holding times are derived based on ‘stability’; the ability of a property to remain unchanged, within a stated uncertainty, under given storage conditions and a specific timeframe. If a reported result is within the holding time it is known that the degree of change (if it occurs) is not statistically meaningful. If the sample result is reported as ‘deviating’ the degree of change is unknown and, therefore, may have affected the result. The result must, therefore, be treated as potentially indicative.

Table 5.2: Groundwater Exceedances of Freshwater EQS

BH ID	Sampling Date	Determinand	Concentration (µg/l)	GAC (µg/l)
2K5500SR	16/05/23	Chromium (VI)	**5**	3.4
	18/07/23	Fluoranthene	**0.79**	0.0063
		Benzo(ghi)perylene	**0.26**	0.0082
	12/09/23	Fluoranthene	**0.12**	0.0063
	18/07/23	Total Ammonia (N)	**601.2**	200 – 600*
	12/09/23		**502.4**	
	16/05/23		**897.6**	
	30/07/24		**798.8**	
2K5501SR	11/05/23	Total Ammonia (N)	**337.6**	200 – 600*
	11/05/23	Nickel	**65**	4
		Zinc	**35**	10.9
		Fluoranthene	**0.52**	0.0063
		Phenol	**9**	7.7
	24/07/23	Nickel	**30**	4
		Mercury	**0.08**	0.07
		Phenol	**34.6**	7.7
	12/03/24	Total Ammonia (N)	**296.5**	200 – 600*
3K5606SA	10/01/24	Total Ammonia (N)	**700**	200 – 600*
	30/11/23		**798**	
	08/03/24		**700**	
	30/11/23	Fluoranthene	**0.02**	0.0063
	08/03/24		**0.25**	
	10/01/24	Sulphate (SO_4)	**588,000**	250000
	30/11/23		**575,000**	
	08/03/24		**602,000**	
3K5525DR	08/03/24	Phenol	**0.7**	0.5

*Based on the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 for good to high river quality.

Table 5.3: Groundwater Exceedances of DWS and WQS

BH ID	Sampling Date	Determinand	Concentration (µg/l)	GAC (µg/l)
2K500SR	18/07/23	TPH (C_{10}-C_{40})[2]	**420**	10[1]
	12/09/23		**110**	
	18/07/23	Ammonium (NH_4)	**772.9**	500
	12/09/23		**645.9**	
	16/05/23		**1,154.1**	
	30/07/24		**1,027.1**	
		TPH (C_{10}-C_{40})[2]	**<2200**	10[1]
2K5501SR	11/05/23	TPH (C_6-C_{40})[2]	**42,200**	10[1]
	24/07/23	GRO (C_6-C_{10})	**242**	
		TPH (C_6-C_{40})[2]	**3,160**	
	12/03/24		**<2,200**	
	09/04/24	TPH aliphatic (C_8-C_{40})[2]	**480**	
	12/03/24	Arsenic	**16**	10
		Sodium	**33,500**	200,000
	09/04/24	Nickel	**21**	20
	12/03/24		**23**	
3K5606SA	10/01/24	Ammonium (NH_4)	**900**	500
		Sulphate (SO_4)	**588,000**	250000
	10/01/24	TPH (C_6-C_{40})[2]	**110**	10[1]
	30/11/23		**290**	
	08/03//24		**7,210**	
	30/11/23	Ammonium (NH_4)	**1,027.1**	500
		Sulphate (SO_4)	**575,000**	250000
	08/03/24	Ammonium (NH_4)	**900**	500
		Sulphate (SO_4)	**602,000**	250000
3K5525DR	10/01/24	Chloride	**338,000**	250000
	30/11/23		**444,000**	
	08/03/24	TPH (C_6-C_{40})[2]	**<2,200**[3]	10[1]
	10/01/24		**120**	
	30/11/23		**<11,000**[3]	

[1] Withdrawn Water Supply (Water Quality) Regulations 1989 GAC.
[2] TPH clean-up was not carried out.
[3] The laboratory stated that the sample was extracted on a x100 dilution for TPH and PAH which has resulted in a raised method detection limit.

Analytes with a laboratory MDL greater than the EQS used for the assessment are shown in **Appendix C**. While the laboratory did not detect these determinands in the sample, they may be present at a concentration above the GAC; however, in the absence of detected concentrations, these are not considered true exceedances.

Groundwater sample deviations and potential contaminants for which the laboratory MDL exceeded the corresponding GAC are presented in **Appendix C**. It is noted that testing with an MDL lower than the GAC for the PAHs listed is typically not offered by standard commercial laboratories.

Further details on the selection of water assessment criteria protective of human health and aquatic ecosystems (controlled waters) is provided in **Appendix G**.

5.3 Excavated Materials (Waste) Management

5.3.1 Hazardous Properties

Soil analytical results for the 42 No. soil samples described above have been screened for hazardous properties as identified in Technical Guidance WM3 - Waste Classification - Guidance on the Classification and Assessment of Waste First Edition Version 1.2 (Environment Agency, 2021). This screen was carried out using HazWasteOnline (HazWasteOnline (a), 2024) (HazWasteOnline (b), 2024). The results are provided in **Appendix E. Table 5.4** below displays the findings from the HazWasteOnline Assessment.

Table 5.4: Waste Classification – Hazardous Soils

BH ID	Sample Depth and Stratum (m bgl)	Determinand	Concentration (% w/w)	Hazardous Properties
2K5500SR	0.5 m (Made Ground)	Asbestos cement (chrysotile)	**0.147%**	H7 Carcinogenic

The remainder of the soil matrix for soil sample 2K5500SR at 0.5 m is classified as non-hazardous. All other Section K soil samples analysed as part of Phase 2 and Phase 3B/3C are classified as non-hazardous material.

5.3.2 Waste Acceptance Criteria (WAC)

WAC testing was completed in accordance with BSEN 12457/2 on three soil samples (one Made Ground, one River Terrace Deposits and one Head deposits) retrieved from 2K5500SR and 2K5501SR (Phase 2) and nine samples (three Made Ground, two Alluvium deposits and four London Clay Formation) retrieved from 3K5511DS, 3K5527DR, 3K5530HP, 3K5606SA, 3K5609HP and 3K7542IT (Phase 3B/3C).

Results were screened against inert waste landfill WAC limit values. A summary of exceedances is provided below:

- Sample 2K5500SR at 4.5 m bgl (River Terrace Deposits) marginally exceeded the inert threshold for antimony (0.08 mg/kg vs limit of 0.06 mg/kg).
- Samples 3K5530HP and 3K5609HP at 1.0 m bgl London Clay Formation) exceeded the inert threshold for fluoride (15 mg/kg vs limit of 10 mg/kg).

Although asbestos was detected at a concentration in excess of the hazardous properties threshold (0.1%) in the Made Ground of 2K5500SR at 0.5 m bgl, given the remainder of the soil matrix is non-hazardous / inert, this stratum could potentially be disposed of in an asbestos cell at a non-hazardous landfill.

No WAC testing was completed from soil samples taken from the location of PSC 132 Infilled Land – Pond (2K5502DS, 2K5503DS, 2K5534DS and 2K5535DS).
It is important to note that specific inert landfills may have stricter and/or additional limits imposed for waste soil disposal, therefore the above assessment shall be treated as indicative only. Suitability of material for disposal must be discussed with the landfill operator in advance. It is likely that additional soil sampling with

chemical and WAC testing will be required beyond this preliminary ground investigation to inform on suitable disposal routes. Topsoil is not normally accepted at landfill due to its high organic content.

5.4 Ground Gas Monitoring

Ground gas monitoring results for monitoring wells 2K5500SR, 2K5501SR, 3K5525DR and 3K5606SA are tabulated in SOCOTEC's Ground Investigation Reports (SOCOTEC, 2023) (SOCOTEC, 2024). There were seven gas monitoring events between May 2023 and November 2023 for 2K5501SR, in addition to seven further rounds of monitoring up to April 2024 for select parameters only. 2K5501SR was monitored on a single occasion during April 2024. Monitoring of the Phase 3B/3C installations took place between November 2023 and April 2024.

The November 2023 monitoring event was completed during falling atmospheric pressure. Peak concentrations (minimum for oxygen) during each monitoring round are presented in **Table 5.5** and in the summary tables in **Appendix F**. On each of these monitoring occasions, the groundwater level was above the top of the installation response zone for Phase 2 exploratory holes and 3K5606SA was flooded.

In view of the flooded wells, the data from these monitoring rounds have been assessed as indicative, due to "The response zone of the gas monitoring standpipe should be wholly or partly above groundwater level to provide valid data... [and] gas standpipes with flooded response zones might exhibit measurements of elevated methane or carbon dioxide… due to dissolved gases or the presence of biodegradable material in the groundwater" (BSI, 2015a).

Although there are no permanent building structures proposed for these areas of the scheme, the ground gas data recorded at this location should be considered at the preconstruction phase as temporary deep excavations are planned as reception pits for the trenchless crossing of the River Hamble.

Peak concentrations (minimum for oxygen) are presented in the summary **Table 5.5**.

5.4.1 Gas Thresholds

Peak concentrations recorded in monitoring wells have been compared to the following gas threshold concentrations:

- BSI (The British Standards Institution) Health and Safety in tunnelling in the construction industry - Code of Practice [BS 6164:2019] (BSI, 2019).
- EH40/2005 (fourth edition 2020) Workplace Exposure Limits (WELs) (HSE, 2020).

Exceedances of these thresholds are shown in **Table 5.6**.

5.4.2 Gas Risk Assessment

Given that BPT-K location is expected to contain building structures, a ground gas risk assessment is required to determine the risks to new buildings. A Gas Screening Value (GSV) has been calculated according to BS8485:2015+A1:2019 (BSI, 2015a).

GSV (litres of gas/hour) = max borehole flow rate (l/h) x max gas concentration of CH_4 or CO_2 (%).

Using the recorded peak CO_2 concentration of 2.6% vol and the worst-case flow rate of 46.3 l/hr recorded at 3K5525DR (screened across Alluvium and London Clay Formation), the GSV is calculated to be 1.2038 l/h which corresponds to a Moderate risk classification (Characteristic Situation (CS) 3), whereby gas protection measures would be required in buildings. However, given the inconsistent gas flow readings recorded ranging

from -19.3 l/hr to 46.3 l/hr, additional gas flow monitoring should be considered at this location to further characterise the gas regime.

Table 5.5: Ground Gas Monitoring Results Summary

Peak Gas Concentrations (minimum for Oxygen)								
Borehole / Purpose	**Response Zone and Stratum**	**CH_4 %vol**	**CO_2 %vol**	**O_2 %vol**	**CO ppm**	**H_2S ppm**	**VOC ppmv**	**Max Gas Flow Rate (pk) l/hr**
2K5500SR Trenchless crossing / 65 m south of PSCs 121,122, and 123 (Infilled – Land – Channels).	3.0 to 7.0 m (River Terrace Deposits and London Clay Formation)	0.8	0.6	8.8	4	1	0.9	20.9*
2K5501SR Trenchless crossing / investigate PSC 119 infilled Ground – Channel)	1.0 to 2.0 m (Head Deposits)	8.7	2.3	16.2	<0.1	25	6.4	<0.1
3K5525DR BPT-K Location / investigate PSC 474 - Wintershill Hall c.35 m south	0.75 to 5.25 m (Alluvium and London Clay Formation)	0.2	2.6	1.0	4	<10	0.6	46.3
3K5606SA Open cut / c.140 m north of Wintershill Road	6.0 to 10.0 m (London Clay Formation)	0.2	3.2	9.6	10	<10	0.8	54.1

CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds, ppmv - Part per Million Volume
*Pump flow failed

Table 5.6: Exceedances of Gas Thresholds

Area	BH ID	CH_4	CO_2	O_2	CO	H_2S	VOC
Location / Substance (threshold)		4.4% (LEL) to 17% (UEL)	0.5% (LTL) 1.5% (STL)	<19% by volume	20 ppm (LTL) 100 ppm (STL)	5 ppm (LTL) 10 ppm (STL)	Approx. 10000 ppmv[1] (LEL)1
2K5500SR	2K5500SR	N/A	Yes (LTL only)	Yes	N/A	N/A	N/A
2K5501SR	2K55001SR	Yes (LEL)	Yes	Yes	N/A	Yes (STL)	N/A
3K5525DR	3K5525DR	N/A	Yes	Yes	N/A	N/A	N/A
3K5606SA	3K5606SA	N/A	Yes	Yes	N/A	N/A	N/A

Notes: N/A = not applicable due to no exceedance, LEL – Lower explosive limit, UEL – Upper explosive limit, STL – Short Term Limit (15-minute reference period), LTL [1] – Long Term Limit (8-hour reference period)

6 Land Contamination Risk Assessment Model

6.1 Approach and Revised Conceptual Site Model

The land contamination risk assessment presented in this section is a revised risk assessment and has been undertaken in accordance with the procedure outlined in LCRM (Environment Agency, 2023). This revised risk assessment uses information collated as part of the Phase 2 and Phase 3B/3C GIs, and builds on the existing preliminary risk assessment completed as part of the desk study. The revised risk assessment will allow for recommendations to be made based on the identification and assessment of potential contaminant linkages. A summary of the guidance for the assessment of land contamination and the approach developed and adopted by SSP is presented in the Summary Report HWTWRP Geotechnical and Geo-environmental Interpretative Summary Report (Ref. 710166-SWS-XX-XX-RP-GE-00100).

6.2 Potential Sources of Contamination

A summary of the on Site and off-Site potential sources of contamination (PSCs) identified and associated potential contaminants of concern (PCOC) are presented in **Table A1.1 and A1.2** for the route, and in a standalone desk study for the BPT-K Site, presented in **Appendix A.** The PSCs and GI data are discussed below.

6.2.1 Locations where PSCs were Identified

Infilled Land - Pond (PSC 132)

- Exploratory holes (2K5502DS, 2K5503DS, 2K5534DS and 2K5535DS) were completed at the location of a former pond (PSC 132) and comprised four hand dug inspection pits terminated at a maximum depth of 0.9 m bgl. The GI had proposed drilling to 6 m bgl, but due to the presence of a high-water table, soft ground conditions and pit collapse this did not occur.
- Made Ground was only encountered at one location to 0.6 m bgl, below which were Alluvial deposits. Alluvial deposits were encountered directly below topsoil in all other GI locations.
- Although chemical analysis was scheduled on collected soil samples from these hand pits, no analytical results have been reported (SOCOTEC, 2023). The lack of chemical analysis provides uncertainty to the concentrations of PCOCs within this specific area of the proposed DoL.
- Exploratory hole 2K55001SR associated with a former pond (PSC 132) could not be investigated further during Phase 2 GI due to the encountered ground conditions.

Infilled Land – Made Ground (asbestos) (PSC 514) and PSCs 119 (on Site) 121, 122 and 123 (Infilled Land – Channels)

- Information collected during the Phase 2 GI from exploratory holes 2K5500SR (which targeted a trenchless crossing and is located c. 65 m south of PSCs 121, 122 and 123) and 2K5501SR (which targeted a trenchless crossing point and PSC 119) did not record exceedances of GAC for the PCOCs tested in soils.
- Asbestos cement (chrysotile) was identified in the Made Ground of 2K5500SR at 0.5 m bgl (0.147%) (PSC 514) at a concentration in excess of the hazardous properties' threshold of 0.1%. No visual identification of asbestos was noted on the borehole log. Made Ground was encountered to 0.7 m bgl at this location. The borehole is within a field and close to the Botley Road (B3035).
- The results of a single soil leachate sample were retrieved (2K5501SR at 6.0 m bgl (London Clay). Exceedances of the adopted GAC were detected for ammonia and total ammonia (N); however, these exceedances are not significant as the potential analytical error by the lab is greater than 1.0 µg/l.
- Groundwater samples taken from monitoring wells at these trenchless locations detected concentrations of contaminants above the adopted GAC for metals (nickel, arsenic, zinc, mercury,

chromium (VI)), phenols, sulphate, total ammonia (N), sodium, chloride, ammonium, fluoranthene, TPH (C_6-C_{40}), aliphatic TPH (C_8-C_{40}) and GRO (C_6-C_{10}) and benzo(ghi)perylene. The highest TPH (C_6-C_4) concentration was recorded in 2K5501SR at 42,200 µg/l on 11th May 2023 (first groundwater sample). The source of TPH is unconfirmed, however, high concentrations of TPH in groundwater could be related to the absence of a TPH clean up on the samples.

- Ground gas monitoring recorded peak concentrations of methane at 8.7 % vol (2K5501SR), carbon dioxide at 2.3 % vol (2K5501SR), carbon monoxide at 4 ppm (2K5500SR) and hydrogen sulphide at 25 ppm (2K5501SR), with a minimum concentration of oxygen at 8.8% vol (SK5500SR).

Worked Ground – unspecified (PSC 530)

- 3K5511DS targeted the location of Worked Ground – unspecified - PSC 530. Made Ground was encountered to a depth of 1.60 m bgl.
- There were no exceedances of GAC in soils chemically tested from this location.
- Soil leachate testing was not completed and there was no groundwater or ground gas monitoring.

6.2.2 Location where Unexpected Contamination was Identified

- 3K5606SA excavated to obtain information on geology along the route, located approximately 140 m north of Wintershill Road.
- Groundwater was sampled and chemically tested from 3K5606SA on three occasions. The response zone for this well was across the London Clay Formation. Exceedances of the adopted GAC were recorded for fluoranthene, sulphate, TPH (C_6-C_{40}) (maximum concentration of 7,210 µg/l), total ammonia (N) and ammonium (NH_4). It is noted that the TPH analysis was not subject to clean-up at the laboratory which may explain the high concentrations.
- The peak carbon dioxide concentration at 3.2 % vol for 3K5606SA exceeds the 0.5 %vol (LTL) and 1.5 %vol (STL) gas thresholds. Low levels of oxygen were also detected at a minimum concentration of 9.6 % vol.

6.2.3 Proposed BPT-K

- Six exploratory holes were completed at the proposed BPT-K Site, with five of these also investigating nearby Wintershill Hall (former military / civilian base) (PSC 474) approximately 35 m south.
- There were no exceedances of GAC in soils chemically tested from the locations.
- Groundwater was sampled and chemically tested from 3K5525DR on three occasions. The response zone for this well was across Alluvium and London Clay Formation. Exceedances of the adopted GAC were recorded for phenol, TPH (C_6-C_{40}) (maximum concentration of <11,000 µg/l) and chloride. It is noted that the TPH analysis was not subject to clean-up at the laboratory which may explain the high concentrations.
- The peak carbon dioxide concentration of 2.6 % vol at 3K5525DR exceeds the 0.5 % vol (LTL) and 1.5 % vol (STL) gas thresholds. The GSV for 3K5525DR is 1.2037 l/h, which corresponds to a moderate risk (CS3) whereby gas protection measures would be required for new buildings. Although gas readings were not significantly high and may be typical of gas concentrations generated from Alluvial deposits, the maximum flow rate of 46.3 l/hr is significant and contributes to the CS calculation. Due to inconsistent gas flow readings recorded at this location, ranging from -19.3 l/hr to 46.3 l/hr, further investigation should be considered to inform on the ground gas regime.

6.3 Identification of Potential Pathways

During and post construction of the new DoL for Section K and BPT-K, the following potential exposure pathways are considered:

- Dermal contact, ingestion and inhalation of dusts, fibres, gases and vapours.
- Gas and vapour migration and accumulation into future buildings and buried services (BPT-K), and accumulation in voids and below ground chambers/receptor pits.
- Surface water runoff from stockpiles to surface watercourses and migration through groundwater.
- Leaching through unsaturated soil to underlying groundwater.
- Migration of contamination through proposed pipe bedding.

6.4 Identification of Potential Receptors

Based on the proposed construction works, end use and surrounding land uses, risks to the following potential receptors previously identified in the desk study PRA have been further assessed following Phase 2 and 3B/3C GI data:

- Construction workers.
- Future Site users (workers and maintenance workers).
- Adjacent land users (applicable to PSCs within DoL only).
- On Site existing and future property (buildings and buried services within BPT-K).
- Surface water (River Hamble, Bow Lake and unnamed drains).
- Groundwater (Secondary A aquifers (River Terrace Deposits and Alluvium).
- Ecological receptors (flora and fauna) including Kimber Copse Ancient Woodlands (within 250 m of the DoL).

The proposed DoL has not been included as a potential receptor to contaminants that could be present in soils or groundwaters because the pipe material selection, which will be made during design, will prevent impact from existing PSCs.

6.5 Risk Assessment

The above CSM has been used to undertake a generic quantitative risk assessment. The method of risk evaluation adopted is consistent with LCRM (Environment Agency, 2023) and is being carried out in accordance with CIRIA C552 (CIRIA C552, 2001). Further details regarding the generic risk assessment methodology used are included in **Appendix I**.

The risk estimation is based on the evaluation of both desk study information collated for the DoL with the Phase 2 and 3B/3C GI data and is presented in **Tables H1** to **H6 (Appendix H)**. Definitions for probability and consequence of **Appendix I**. The findings of the revised risk assessment are summarised in **Tables 6.1**.

Table 6.1 summarises the risk classification (without mitigation measures) for the investigated PSCs, the BPT-K site and exploratory hole locations where unexpected contamination was encountered. The risk classification ratings are taken from the risk assessment tables (**Appendix H**). Where more than one pathway has been evaluated, the pathway with the highest risk rating is presented in **Table 6.1**. For example, the risk rating for construction, maintenance workers and future site users is High for an inhalation pathway and is shown in **Table 6.1**. The dermal contact and ingestion pathway risk rating is low as presented in Appendix H and is, therefore, not presented in **Table 6.1** but is expanded upon further in **Appendix H**.

Table 6.1: Summary of Risk Classification for Construction and Maintenance Activities for Areas Investigated in Section K

PSC No.	Location within Section K	PSCs	Risk Classification (without mitigation measures) for Potential Receptors [1]					
			Construction, maintenance workers and future Site users	Adjacent Land Users	On Site existing and future property (buildings and buried services)	Surface Water	Groundwater	Ecology
Section K DoL								
119	Close to receptor pit for trenchless crossing	**Infilled Land - Channel:** Potential for Made Ground/infill of unknown material (on Site). Limited GI data collected to investigate PSC fully.	Moderate/Low	Moderate/Low	Low	Moderate	Moderate	Very Low
132	Close to receptor pit for trenchless crossing	**Infilled Land - Pond:** Potential for Made Ground/infill of unknown material (on Site). Limited GI data collected to investigate PSC fully.	Moderate/Low	Low	Very Low	Moderate/Low	Low	Very Low
None	Land South of Botley Road trenchless crossing.	**Asbestos in Land South of Botley Road (2K5500SR)** Asbestos cement (Chrysotile) identified in Made Ground.	High *(Inhalation of dust/fibres pathway)*	Moderate *(Inhalation of dust/fibres pathway)*	Low	Moderate	Moderate	Very Low
530	c. 430 m southwest of Wintershill	**Worked Ground – unspecified (3K5511DS):** Potential for Made Ground/infill of unknown material (on Site)	Moderate/Low *(Inhalation pathway)*	Low	Low	Moderate/Low	Moderate/Low	Very Low
None	3K5606SA, c.140 m north of Wintershill Road.	Exceedances of groundwater GAC for fluoranthene, sulphate, TPH, total ammonia (N) and ammonium (NH_4). Carbon dioxide exceeds STL gas thresholds, coupled with low oxygen levels.	Moderate/Low *(Inhalation pathway)*	Low	Low	Moderate/Low	Very Low	Very Low
BPT-K								
474	35 m south of BPT-K Site	**Wintershill Hall (former military/civilian base)** (off-Site).	Moderate *(Inhalation pathway)*	N/A (due to absence of an on Site PSC)	Moderate *(Gas migration and accumulation)*	N/A (due to absence of surface water receptors within 250 m)	Very Low	N/A (due to absence of ecological receptors within 250 m)

[1] based on available analytical data
N/A not assessed

6.6 Summary

6.6.1 BPT-K AGP

The Phase 3B/3C GI at the BPT-K AGP location focussed on assessing ground conditions as well as investigating nearby PSC 474 – Wintershill Hall (military and civilian base). Geo-environmental soil and groundwater sampling and testing, and ground gas monitoring was undertaken. Based on the generic quantitative risk assessment the following risks were determined:

- There were no concentrations of contaminants detected in excess of Commercial GAC protective of human health in soils, nor any asbestos detected in soils at the BPT-K AGP location.
- Peak carbon dioxide concentrations detected during monitoring (2.6 % vol) were above the STL and LTL gas thresholds (3K5525DR, response zone across Alluvium and London Clay Formation). The gas screening value calculated to determine the risk from gas ingress into new buildings indicated a Moderate risk (CS3 classification) whereby gas protection measures would be required in new buildings. The gas source detected during the GI is unconfirmed. Additional monitoring to confirm the ground gas regime at the BPT-K AGP should be considered given the inconsistent gas flow readings.
- Overall, a Moderate risk classification has been identified for impact to construction, maintenance workers and future site users from inhalation of ground gases. Low risks have been identified for impact to construction, maintenance workers, and future site users from direct dermal contact, ingestion, and inhalation of dusts.
- Risks to adjacent land users have been dismissed given that PSCs have not been identified on Site of the BPT-K AGP. Furthermore, risks to surface water bodies / watercourses and ecological receptors have been dismissed based on the absence of these receptors on Site at the BPT-K AGP location.
- Although some PCOCs were detected in groundwater and soil leachate sampled from the BPT-K AGP location at concentrations above the GAC, risks to groundwater have been identified to be Very Low due to the underlying unproductive stratum (London Clay).

6.6.2 Section K DoL

Phase 2 GI

The Phase 2 GI at Section K DoL focused on PSC 132 – Infilled Land – Pond and PSC 119 Infilled Land – Channel, in addition to nearby potentially infilled channels (PSCs 121, 122, and 123). Trenchless crossing locations and linear locations were also targeted.

The GI borehole locations at the infilled pond (PSC 132) were all hand pits and terminated at 0.9 m bgl due to the presence of a high-water table, which led to soft ground conditions and pit collapse. Made Ground was only encountered at one Phase 2 location to 0.6 m bgl below which were Alluvium deposits. An organic odour between 0.6 m and 0.7 m bgl in the Alluvium underlying the Made Ground was noted in one borehole log (2K5502DS). This was assumed to be natural; it corresponds to the description grey mottled black sandy silt (organic matter). Alluvium deposits were also encountered directly below topsoil in all other GI locations. Although no significant thickness of Made Ground material was encountered, the absence of chemical analysis means that there is uncertainty as to the concentrations of PCOCs within this specific area of the DoL.

Based on the risk assessment, a risk classification of Moderate/Low impact to adjacent surface watercourses has been identified based on the potential for PCOCs to be present in concentrations that would exceed the GAC. A Moderate / Low risk rating for impact to human health for construction and maintenance workers via direct contact and inhalation of gases and vapours has been identified based on the potential for infilled land to be present and in the absence of further GI data including gas monitoring. All other identified potential contaminant linkages were either identified as Low or Very Low risk.

There were no exceedances of PCOCs in soils at locations investigated at the trenchless crossing points north and south of the River Hamble (2K5500SR and 2K5501SR). Asbestos (chrysotile) cement (PSC 514) was identified in 2K5500SR at 0.5 m bgl in Made Ground at a concentration classified as hazardous. As the remainder of the soil matrix tested is classified as non-hazardous, the Made Ground stratum containing asbestos could potentially be disposed in an asbestos cell at a non-hazardous landfill.

Contaminant concentrations in groundwater above the GAC for metals (nickel, zinc, mercury and chromium (VI)), phenol, fluoranthene and benzo(ghi)perylene were detected. TPH (C_6-C_{40}) concentrations above the (withdrawn) GAC of 10 µg/l were detected at both locations at least once during the monitoring period with the highest concentration recorded in 2K5501SR (42,200 µg/l) on 11th May 2023. Although there is no measurement of free product at the wells, this concentration is significant and may indicate the presence of free product. The source of TPH in groundwater is unconfirmed. If during construction dewatering is required, PCOCs in groundwater will need to be considered prior to disposal.

Ground gases were recorded at concentrations above their detection limits at the monitoring well south of the Botley Road. Groundwater levels were recorded above the top of the installation response zone (flooded) during all ground gas monitoring rounds therefore the data should be considered to be indicative. Although there is no permanent building structures proposed for this area of the scheme, the ground gas data recorded at this location should be considered at the preconstruction phase as temporary deep excavations are planned as reception pits for the trenchless crossing of the River Hamble.

A risk classification of a High for potential impact to human health of construction workers and future site users have been identified at the area where asbestos (Chrysotile) was recorded in Made Ground at the GI location south of Botley Road (a possible location for a temporary reception pit). A Moderate risk rating for at this location for adjacent Site users has also been identified based on the presence of asbestos. A risk classification of a Moderate for impacts to groundwater and surface water has been identified based on the presence of adjacent watercourses which may be in hydraulic continuity with groundwater beneath the Site, and the presence of PCOCs detected in groundwater samples.

A risk classification of a Moderate/Low for potential impact to human health of construction workers, adjacent Site users and future Site users have been identified for the area of land in the proximity PSC 119 (north of trenchless crossing) based on the potential exposure to identified PCOCs in groundwater. No gas monitoring was completed in this area, and although no Made Ground / fill material was encountered during the GI, there is the potential for the presence of ground gas from infilled channels in the surrounding area (PSC 119, 121, 122 and 123).

All other identified potential contaminant linkages were either identified as Low or Very Low risk.

Phase 3 GI

Exploratory hole 3K5511DS was completed as part of the Phase 3B/3C GI and targeted the location of Worked Ground – unspecified (PSC 530). Made Ground was encountered to a depth of 1.60 m bgl, potentially confirming the presence of worked ground. There were no exceedances of GAC in soils chemically tested at this location. Soil leachate testing was not completed. A monitoring well was not installed into the borehole. A Low risk classification has been identified for potential impact to the health of construction workers, maintenance workers and future site users, and adjacent Site users. In the absence of groundwater and soil leachate data, Moderate/Low risks were identified to surface water and groundwater receptors considering the presence of an on Site drainage channel and the underlying Secondary A Aquifer (Alluvium). All other identified potential contaminant linkages were either identified as Low or Very Low.

Exploratory hole 3K5606SA, located approximately 140 m north of Wintershill Road, did not target a PSC. There were no exceedances of soil GAC at this location, however, exceedances of groundwater GAC were

detected including TPH (C_6-C_{40}) at a maximum concentration of 7,210 µg/l. It is noted that the TPH analysis was not subject to clean-up at the laboratory which may explain the high concentration. If during construction dewatering is required, PCOCs in groundwater will need to be considered prior to disposal. Ground gas levels at this location included a peak carbon dioxide concentration of 3.2 % vol which exceeds the 0.5 %vol (LTL) and 1.5 %vol (STL) gas thresholds. Low levels of oxygen were also detected with a minimum concentration of 9.6 % vol.

A risk classification of a Moderate / Low for potential impact to the health of construction workers, maintenance workers and future site users via inhalation pathways has been assigned to the location of 3K5606SA. Despite the notable TPH concentrations in groundwater, a Very Low risk classification has been identified to groundwater based on the underlying unproductive stratum (London Clay) and absence of superficial aquifers. Risks to surface water have been identified as Moderate/Low based on the presence of a nearby watercourse which could be potentially impacted through surface water run-off from stockpiled soils (in the absence of soil leachate results to inform on leachable contaminant concentrations). All other identified potential contaminant linkages were either identified as Low or Very Low risk.

7 Geotechnical Testing and Assessment

7.1 Geotechnical Testing and Assessment Summary Tables for Section K boreholes

The below **Table 7.1** shows the varying geotechnical tests per strata specific to Section K. Section K geotechnical testing results are similar to adjacent Section H and Section L, that also encounter similar superficial deposits and bedrock. Results for boreholes in Section L and Section K are comparable regarding classification, SPT results, and geochemical testing results for superficial deposits (Alluvium, Head Deposits, River Terrace Deposits) and London Clay Formation.

Table 7.1: Geotechnical Testing and Assessment Summary for Section K boreholes

Geotechnical Property																							
Strata	**Moisture (%)**			**Plasticity (%)**			**Particle Size Distribution (Average of values)**		**Triaxial Shear Strength (kPa)**				**SPT Results (uncorrected N value)**			**Uniaxial Compressive Strength, UCS (MPa)**	**Compaction – Max Dry Density (Mg/m³) (Optimum Moisture content, %)**			**Linear (Bulk) Density (kg/m³)**		
Made Ground (MGR)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	None				**Min**	**Av**	**Max**	Not Applicable	**Min**	**Av**	**Max**	None		
	18	28	38	7	20	33	**Cobbles**	0					7	7	7		1.83 (12)	1.83 (12)	1.83 (12)			
							Gravel :	38														
							Sand :	11														
							Silt :	36														
							Clay	15														
Total No. of tests	**2**			**2**			**2**		**0**				**1**			**0**	**1**			**0**		
Alluvium (ALV)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	**Min**	**Av**	**Max**		**Min**	**Av**	**Max**	Not Applicable	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**
							Cobbles	0														
							Gravel :	13														
	17	34	77	36	44	73	**Sand :**	7	65	76	87		8	12	15		1.48 (18)	1.63 (22)	1.69 (29)	1.91	1.93	1.97
							Fines : (clay & silt)	80														
Total No. of tests	**9**			**6**			**5**		**2**				**2**			**0**	**6**			**4**		
Head Deposits (HEAD)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	**Min**	**Av**	**Max**		**Min**	**Av**	**Max**	Not Applicable	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**
							Cobbles	8														
							Gravel :	45														
	28	29	30	42			**Sand :**	20	None				4	4	4		1.50 (22)	1.56 (24)	1.62 (26)	1.95	1.95	1.95
							Silt :	15														

Geotechnical Property																										
Strata	**Moisture (%)**			**Plasticity (%)**			**Particle Size Distribution (Average of values)**		**Triaxial Shear Strength (kPa)**			**SPT Results (uncorrected N value)**			**Uniaxial Compressive Strength, UCS (MPa)**			**Compaction – Max Dry Density (Mg/m^3) (Optimum Moisture content, %)**			**Linear (Bulk) Density (kg/m^3)**		
							Clay	13																
Total No. of tests	**2**			**1**			**1**		**0**			**1**			**0**			**2**			**1**		
River Terrace Deposits (RTD)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	Not Applicable			**Min**	**Av**	**Max**	None		
							Cobbles	0																
							Gravel :	32																
	24	24	24	11	11	11	**Sand :**	19	None			4	4	5				1.81 (14)	1.81 (14)	1.81 (14)			
							Silt :	33																
							Clay :	16																
Total No. of tests	1			**1**			1		0			4			0			1			0		
London Clay Formation (LC)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**
							Cobbles	0																
							Gravel :	1																
	19	27	35	23	35	46	**Sand :**	13	29	142 *	240	9	21*	38	0.05	0.13	0.24	1.47 (29)	1.47 (29)	1.47 (29)	1.989	2.00	2.12
							Silt :	47																
							Clay :	40																
Total No. of tests	17			17			6		9			25			16			1			21		

* Increasing with depth

Laboratory California Bearing Ratio (CBR) testing was also conducted:

- Alluvium : 0.2 – 0.5 m (5 tests): CBR Top : 0.7 – 7.2% (Average : 3.2%) CBR Base : 1.8 – 3.8% (Average : 2.6%)
- Head Deposits : 0.3 m (1 test): CBR Top : 7.3% CBR Base : 4.7%

Two tests were carried out on material that has since been re-classified and therefore the results are not considered further. There were no CBR tests done on River Terrace Deposits or London Clay Formation.

Five oedometer consolidation tests carried out on rotary core sub-samples from boreholes: 3K5525DR and 3K5527DR covering a range of loading and unloading cycles, the full results are available in the factual report by SOCOTEC (SOCOTEC, 2024).

Table 7.2: Additional Geochemical Testing

	Geochemical Testing				
Geology	**Organic Matter Content (%)**	**BRE SD1 values[1]**			
Made Ground (MGR)	2.4	**Test type**	**Min**	**Max**	**Characteristic Value**
		Water soluble SO4 (mg/l)	Below limit of detection	18	< 500
		Acid soluble SO4 (%)	0.01	0.04	0.04
		Total Sulphur (%)	0.01	0.02	0.02
		Total Potential Sulphate (%)	0.03	0.06	< 0.24
		pH	7.38	8.30	7.38
No. Tests	1		2		
Alluvium (ALV)	0.4 - 10.22 (Average 5.31)	**Test type**	**Min**	**Max**	**Characteristic Value**
		Water soluble SO4 (mg/l)	20	28	< 500
		Acid soluble SO4 (%)	0.02	0.04	0.04
		Total Sulphur (%)	0.02	0.02	0.02
		Total Potential Sulphate (%)	0.06	0.06	< 0.24
		pH	8.17	8.23	8.17
No. Tests	2		2		
Head Deposits (HEAD)	Not Available	**Test type**	**Min**	**Max**	**Characteristic Value**
		Water soluble SO4 (mg/l)	10	30	< 500
		Acid soluble SO4 (%)	0.03	0.09	0.09
		Total Sulphur (%)	0.07	0.08	0.08
		Total Potential Sulphate (%)	0.21	0.24	0.24
		pH	7.3	7.5	7.3
No. Tests	0		3		
River Terrace Deposits (RTD)	0.84	**Test type**	**Min**	**Max**	**Characteristic Value**
		Water soluble SO4 (mg/l)	20	20	< 500
		Acid soluble SO4 (%)	0.04	0.04	0.04
		Total Sulphur (%)	0.05	0.05	0.05
		Total Potential Sulphate (%)	0.15	0.15	< 0.24
		pH	8.6	8.6	8.6
No. Tests	1		1		
London Clay Formation (LC)	0.27 – 2.34 (Average = 1.12)	**Test type**	**Min**	**Max**	**Characteristic Value**
		Water soluble SO4 (mg/l)	20	400	< 500
		Acid soluble SO4 (%)	0.01	0.21	0.19
		Total Sulphur (%)	Below limit of detection	0.93	0.77
		Total Potential Sulphate (%)	Below limit of detection	2.79	1.3 – 2.4
		pH	7.7	8.7	8.6
No. Tests	4		11		

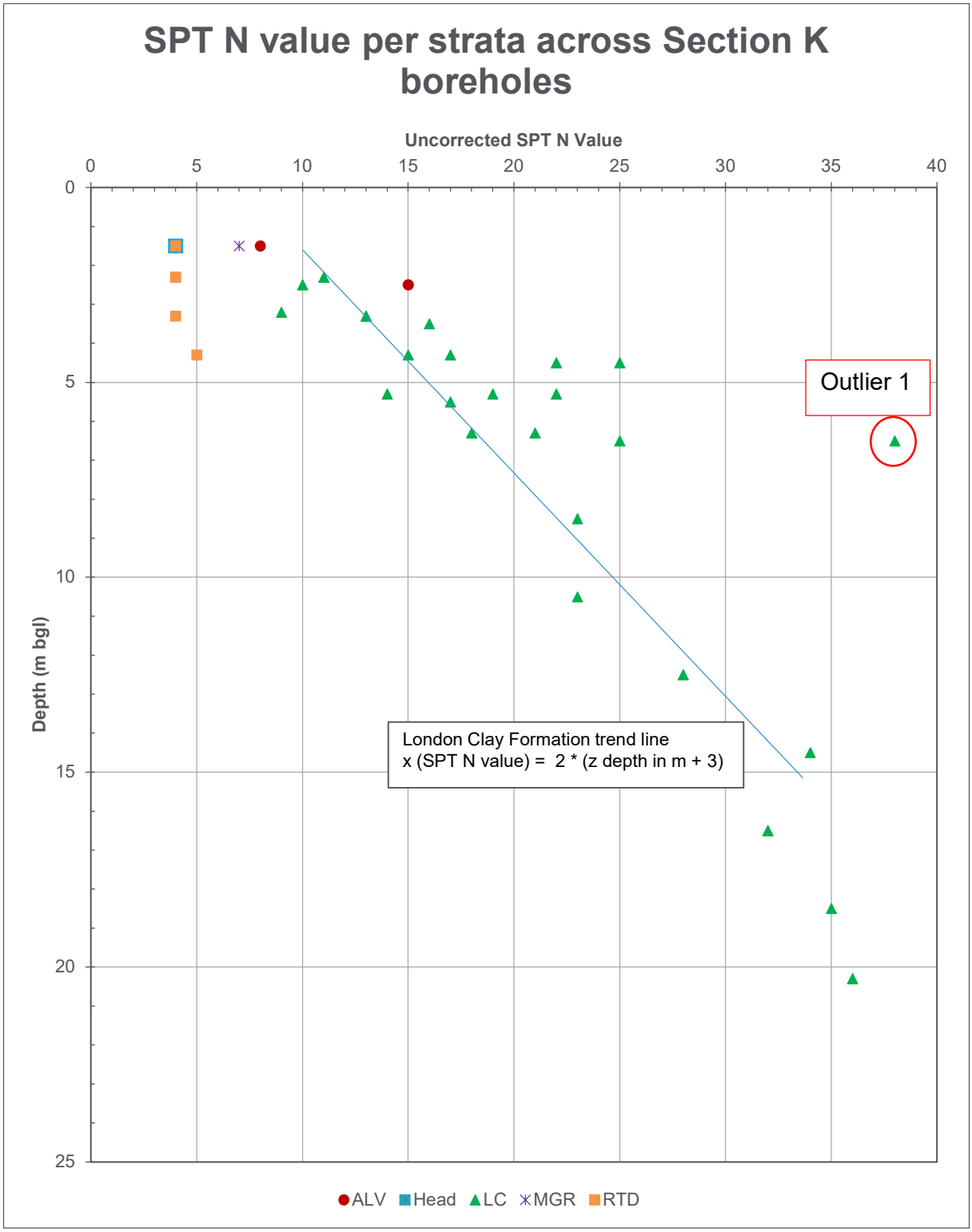
[1] Total Potential Sulphate is calculated from section *C5.1.2* (BRE, 2005) (SOCOTEC, 2024)

7.2 Standard Penetration Test (SPT) vs Depth Relationship for Section K boreholes

Graph 7.1 shows uncorrected SPT N value vs depth for each stratum (Made Ground, Alluvium, Head Deposits, River Terrace Deposits and London Clay Formation).

Both Made Ground (MGR) and Head Deposits (HEAD) only have 1No. SPT test carried out, consequently, both MGR and HEAD do not show a relationship with SPT N value and depth. London Clay Formation (LC) shows a positive relationship in **Graph 7.1** that indicates SPT N values increasing with depth. Outlier 1 shows LC with a SPT N value of 38; this may be a result of a thin limestone/claystone cobble which was encountered at 6.60-6.75m, as described in the borehole log, so the SPT N value may be artificially higher as a result and should be ignored. There were only 2 No. SPT N test values within Alluvium so a relationship cannot be identified in **Graph 7.1**.

Graph 7.1 SPT vs Depth per strata across Section K boreholes



7.3 Undrained Shear Strength (C_u) vs Depth Relationship for Section K boreholes

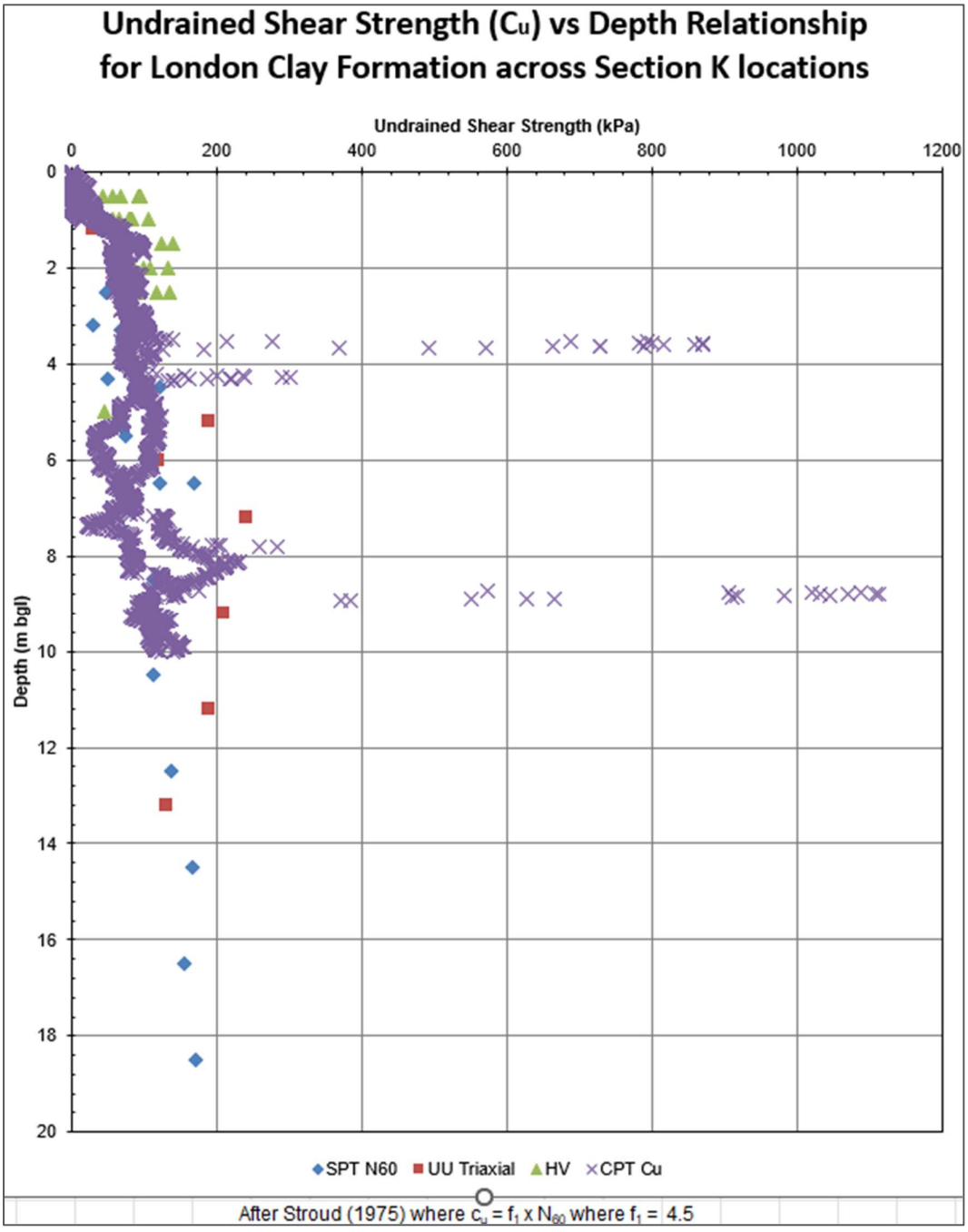
Graph 7.2 shows Undrained Shear Strength vs depth for London Clay Formation from a combination of directly measured shear strength by triaxial testing, and derived from SPT. The limited data available for Alluvium, Head Deposits, Made Ground and River Terrace Deposits is insufficient to define a relationship between Undrained Shear Strength C_u value and depth for those materials.

London Clay Formation (LC) shows a range in undrained strength c_u values from 29 kPa to 240 kPa from laboratory triaxial tests and SPT derived results. (Note the C_u of 240 kPa at 7.2 m bgl at 3K5606SA may be as a result of encountering a claystone band (stiffer than the surrounding very stiff clay) not visible in the separate bulk samples recovered near this depth). SPT N_{60} values show a positive relationship with depth. Hand vane (HV) results in green triangles show too much scatter to be reliable.

Three CPT tests within LC also indicate increasing c_u with depth, similar to SPT results from 0 – 10 m bgl; 2No. holes (3K5521CT and 3K5540CT) were completed to 10 m scheduled depth, and 1No. hole terminated at 3.93 m bgl because there was a sudden inclination of the rods thought to be a result of the CPT probe hitting an obstruction. Obstructions may include coarse gravel or cobble fragments that have a much higher density than the surrounding LC (e.g. perhaps relating to isolated or persistent claystone beds). In the CPT tests which did achieve scheduled depth there were much higher undrained strength results (900 – 1100 kPa) within isolated bands, likely attributed to very dense sand horizons (or perhaps also claystone beds) within LC - at approximately 3.6 m and 8.8 m bgl - there are no boreholes immediately adjacent to allow visual assessment to confirm what these relate to.

Made Ground undrained strength c_u recorded 2 values between 34 – 37 kPa from 0.5 m and 1.2 m bgl respectively. Alluvium c_u recorded 35 values between 40 – 87 kPa from 0.5 m and 2.5 m bgl with a wide scatter proving inadvisable to determine a positive/negative relationship with depth. Head Deposits undrained strength c_u recorded 11 values between 55 – 110 kPa from 0.5 m and 1.2 m bgl without a determinable relationship. River Terrace Deposits undrained strength c_u recorded 4 values between 20 – 26 kPa from 1.2 m to 4 m bgl without any determinable relationship with depth.

Graph 7.2 Undrained Shear Strength C_u vs Depth for London Clay Formation across Section K boreholes



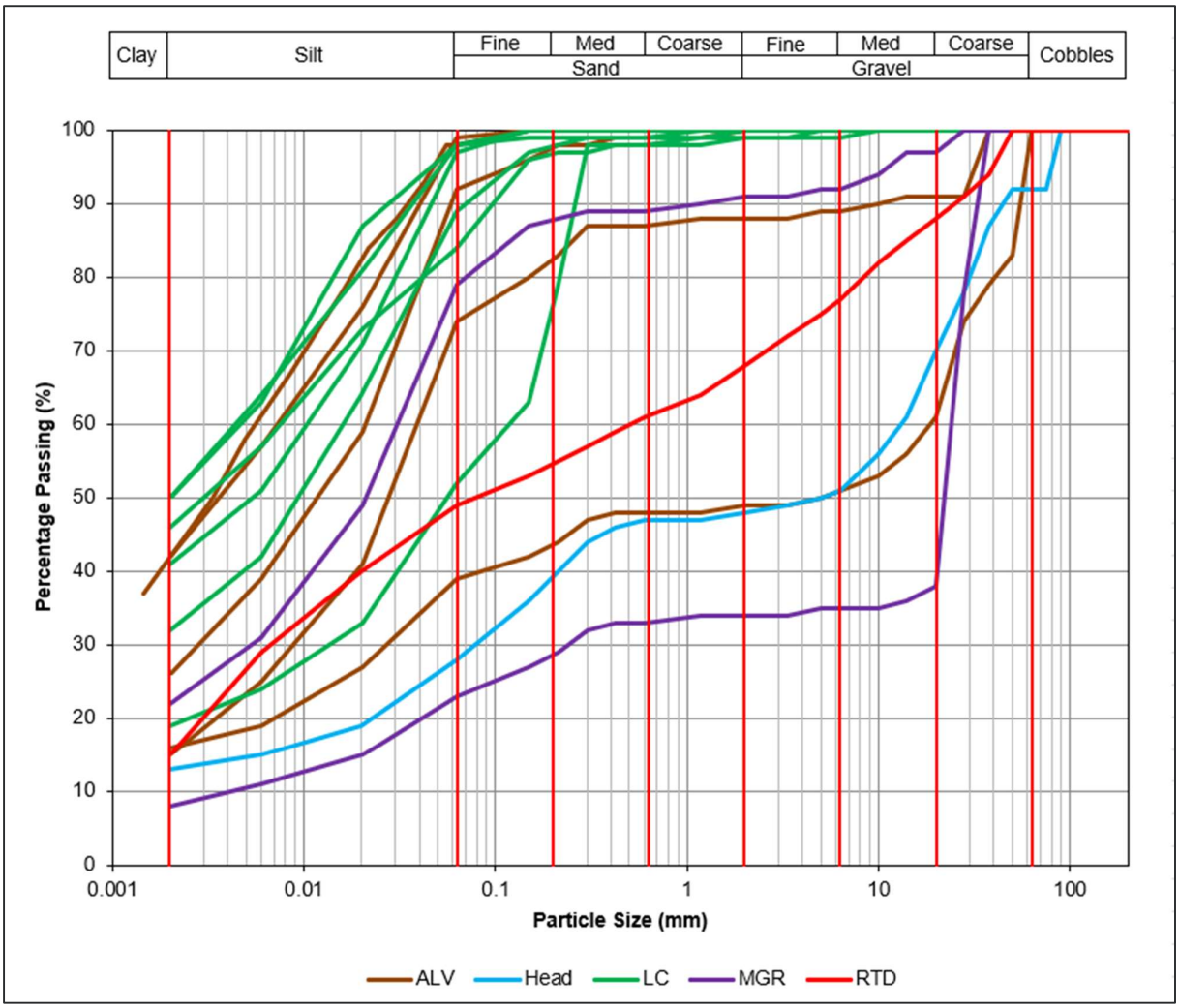
7.4 Particle Size Distribution for Section K boreholes

Graph 7.3 shows Particle Size Distribution per strata across Section K. **Graph 7.3** shows particle size distribution curves for Alluvium and River Terrace Deposits as compatible with the soil descriptions on the borehole logs (i.e. predominantly clay). Whereas with Made Ground and Head deposits PSD plots show silty sandy gravel, which differs from the soil descriptions. Made Ground soil is described as gravelly clay and Head Deposits are highly variable described as gravelly/cobbly clay and clayey gravel.

However, all four of these deposits are variable, containing mixtures of granular and cohesive strata, with which the samples recovered from the boreholes are not necessarily representative. Therefore, the particle size distribution (PSD) results should not be relied upon entirely in this section.

PSD results for London Clay Formation show it to classify as a silty clay, matching the descriptions on the borehole records. .

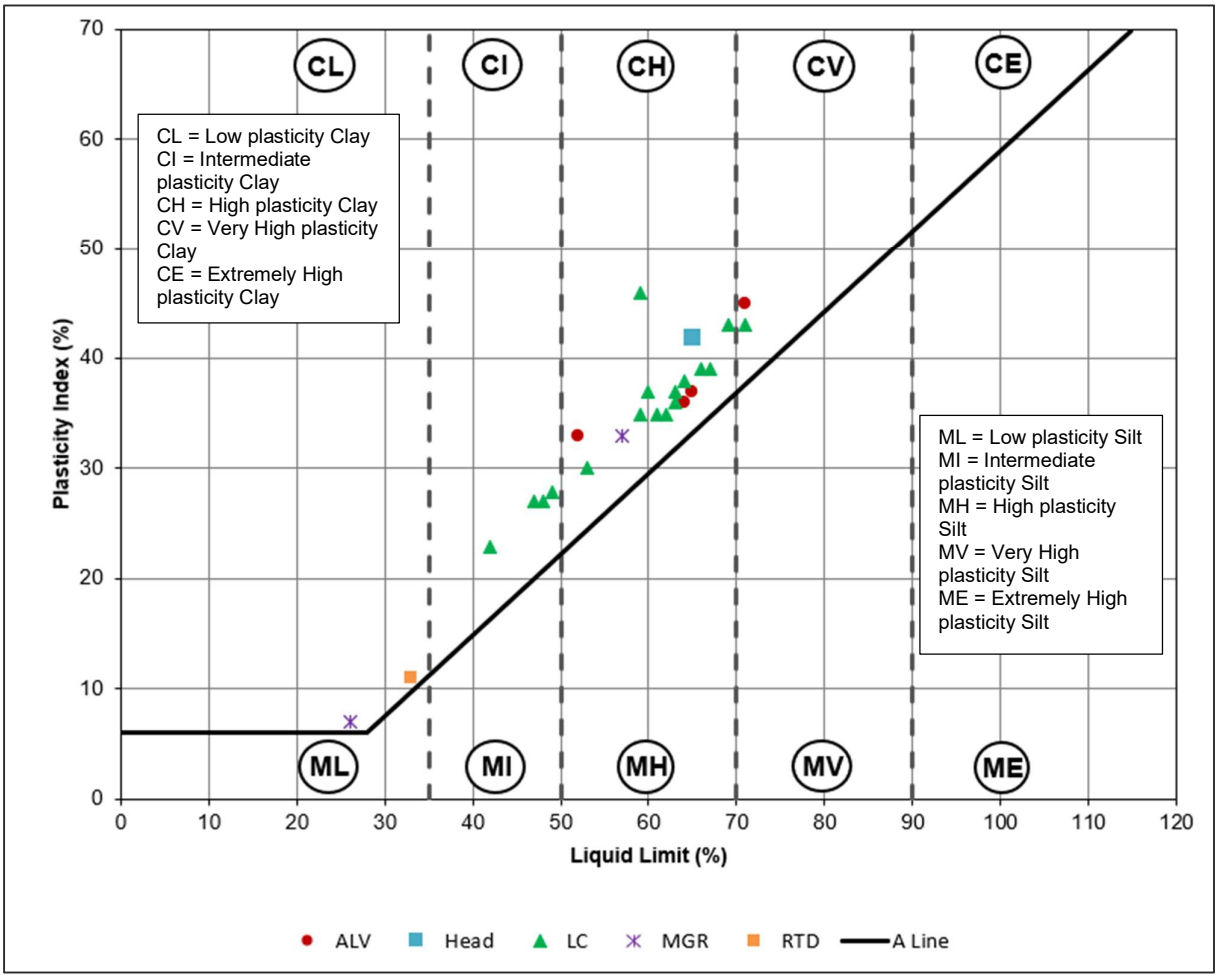
Graph 7.3 Particle Size Distribution per strata across Section K boreholes



7.5 Plasticity for Section K boreholes

Graph 7.4 shows Made Ground and River Terrace Deposits as a low plasticity clay with London Clay Formation ranging between intermediate and very high plasticity clay. Alluvium ranges between high and very high plasticity clay. Head Deposits shows 1 result suggesting high plasticity clay.

Graph 7.4 Plasticity per strata across Section K boreholes



7.6 Geotechnical Design Parameters for Section K boreholes

Based on the soil descriptions and results obtained from the in-situ and laboratory tests, the characteristic values for each stratum have been derived and are shown in **Table 7.3**.

Table 7.3: Geotechnical Design Parameters for Section K boreholes

	Geotechnical Design Parameters									
Strata	**Native Soil Modulus, E'_3 (MN/m^2) [a]**	**Elastic Modulus E_u [b2]**	**Bulk weight density, γ (kN/m^3) [c]**	**Constant volume angle of shearing resistance, φ (°) [c]**	**Undrained Shear Strength, C_u (kPa) [b1]**	**Coefficient of Volume Compressibility, m_v (m^2/MN) [b1]**	**Uniaxial Compressive Strength (MPa)**	**Concrete Aggressivity [d]**	**Earthworks [b2]**	**From PSD results Embedment class with 'as-dug' soils [e]**
Made Ground	Soft clay: 1.5	Short Term: 2 MPa Long Term: 1 MPa	15 – 19	Based on plasticity index average result of 20 %, φ = 26°	20	1.5	Not Applicable	DS-1 AC-1	1 V : 2 – 2.5 H	Variable – unsuitable for re-use
Alluvium (ALV)	Soft clay: 1.5	Short Term: 2 MPa Long Term: 1 MPa	15 – 19	Based on average plasticity result of 44 %, φ = 21°	20	1.5	Not Applicable	DS-1 AC-1	1 V : 3 H	Fine grained, liquid limit >50 %, organic. Unsuitable for re-use
Head Deposits (HEAD)	Firm clay: 3	Short Term: 5 MPa Long Term: 4 MPa	16 – 20	Not available. From nearest sections: based on average plasticity result of 27 %, φ = 24°	40	0.3	Not Applicable	DS-2 AC-2	1 V : 2 – 2.5 H	Potentially selected material suitable as S4 bedding subject to further classification testing including liquid limit and PSD. Locally would be unsuitable due to large clast size (cobbly).
River Terrace Deposits (RTD)	Soft clay: 1.5	Short Term: 2 MPa Long Term: 1 MPa	15 – 19	Based on 1 plasticity result of 11 %, φ = 29°	20	1.0	Not Applicable	DS-1 AC-1	1 V : 1.5 – 2 H	Potentially suitable as S4 bedding – subject to further classification testing including liquid limit and PSD
London Clay Formation (LC)	Firm to very stiff clay: 6	Short Term: 400Cu [b1] Long Term: 240Cu [b1] (most detrimental value to be used for design)	18 – 23	Based on average plasticity result of 35 %, φ = 23°	75	0.1	0.05 – 0.24	DS-4 AC-4	1 V: 2 – 2.5H	Fine grained, liquid limit generally >50 %. Unsuitable for re-use

[a] (BSI, 2020) Table 13
[b1] (Tomlinson, 2001) Table 2.5,Table 2.11, Figure 2.33, Section 2.6.6
[b2] (Look, 2007) Table 11.7, Table 11.8, Figure 14.1, Table 14.10
[c] (BSI, 2015) Figure 2 and Section 4.3.1.4.8
[d] (BRE, 2005) Table C1
[e] (BSI, 2020) Table 24
Table 24 of BS9295:2020 corresponds to Table A.3 from the Water Industry Specification for Bedding and Side fill Materials for buried pipelines WIS 4-08-02 February 1994: Issue 1 document.

7.7 In-situ Electrical Resistivity Testing

In situ apparent resistivity testing was undertaken in Section K hand pit locations, the results are presented in **Table 7.4.**

Table 7.4 Insitu Electrical Resistivity for Section K

BH ID	Electrode spacing (m)			
	4.0	3.0	2.0	1.0
	Apparent Resistivity (mean) (Ω.m)			
3K5513HP	10	11	11	14
3K5515HP	16	16	19	15
3K5529HP	9	13	14	16
3K5604HP	8	9	9	11
3K5607HP	8	10	9	11
3K5608HP	7	8	9	12
3K5610HP	11	11	12	17
3K5630HP	12	16	16	24

A characteristic apparent resistivity value of 7 Ωm should be taken, which indicates that the ground is highly aggressive towards ferrous metals.

8 Geotechnical Considerations

8.1 Ground Conditions

The ground conditions recorded at the GI locations are generally in line with geological mapping for the area.

- Made Ground comprising soft brown/orange sandy slightly gravelly clay has been recorded locally up to 1.60 m bgl (chainages 24750, 27970, 28500, 29500).
- Superficial deposits comprising a mixture of either soft grey mottled black sandy silt with organic odour / soft brown sandy gravelly clay (Alluvium) to 2.5 m bgl (chainages 27700, 28500 and 29500), sandy cobbly clay / grey sandy clayey gravel (Head Deposits) to 2.0 m bgl (various chainages between 24985 till 29350) and soft brown gravelly sandy clay (River Terrace Deposits) are likely to be encountered locally within the upper 4.9 m bgl (chainage 24750).
- London Clay Formation bedrock was encountered to a maximum depth of 30.50 m bgl at 3K5525DR consisting of firm to stiff becoming very stiff clay, locally fissured with sand horizons, shell fragments and pyrite nodules (chainage 24750 till 29930).

Across Section K, superficial deposits are mapped as absent, though records indicate there is a widespread thin covering of Head Deposits (up to around 1.2m), overlying London Clay Formation which is likely to be the founding strata for the 1200 mm diameter ductile iron (DI) pipe in the open-cut sections at between 3 and 6 m bgl. On occasions near watercourses, Alluvium, River Terrace Deposits, and perhaps also thicker sequences of Head Deposits are likely be encountered.

Trenchless crossings such as northwest of Wintershill (near 3K5606SA) at approximately 6 m and 8 m bgl and the River Hamble (near 2K5500SR and 2K5501SR) between 9.7 m and 15 m bgl are expected to be founded within the London Clay Formation bedrock as it was encountered from 2.0 – 4.9 m bgl to the base of each 20 m borehole.

8.2 Foundation Design

For the approximate 5.1 km length of pipeline proposed across Section K; bearing resistance or settlement issues are not anticipated – the pipeline is expected to result in a net reduction in ground bearing pressure at formation level.

However, particularly where soft / organic alluvium is encountered, it is recommended that prior to pipeline construction the soft alluvium is removed and replaced with granular imported fill and/or the pipe bedding is enlarged to account for poor ground support.

8.3 Shallow Excavation

8.3.1 Excavation

Shallow excavations for the proposed open-cut route are expected to be constructed between 3 m to 6m bgl, all within Made Ground, superficial deposits and London Clay Formation bedrock. Excavations are expected to be within the capability of conventional plant.

Full excavation support would likely be required in superficial deposits, particularly where encountered near watercourses or infilled ponds. Four of the inspection pits terminated a maximum depth of 0.9 m bgl due to water strikes, collapse and soft ground being encountered between 0.5 and 0.9 m bgl (these locations

previously targeted an area of infilled ponds for a PSC during the Phase 2 ground investigation). These materials may be highly mobile below the water table.

Where space permits (e.g. in open land), it may be possible to construct the shallow pipework within unsupported battered trenches though sides of the excavation may be prone to drying out and weathering which could cause sides to slip if left open for long periods of time (CIRIA, 1992).

8.3.2 Groundwater Control

Based on the GI records, significant groundwater entries are likely to be encountered in excavations close to watercourses; groundwater was encountered during drilling, and within monthly monitoring at between ground level (+17.75 m OD) and 2.97 m bgl (+20.19 m OD) in the south of Section K (2K5500SR and 2K5501SR). Towards the centre of Section K route (3K5606SA), groundwater varied between 1.17 m to 1.99 m bgl (+43.99 to +43.17 m OD); at 3K5525DR groundwater levels fluctuated between 1.09 m to 1.78 m (41.10 to 40.41 m OD). These groundwater entries are expected to be controllable by conventional sump pumping.

High water levels have been encountered during monitoring, which should be taken into account prior to construction. Groundwater levels and water levels obtained from a downhole data logger at five-minute intervals (within 2K5500SR only), ranged between 1.37 m bgl (+21.79 m OD) to 4.43 m bgl (+18.73 m OD) Geological mapping indicates superficial deposits comprising Alluvium, Head Deposits and River Terrace Deposits within 100 m from the River Hamble especially very close to the river edge nearest to the route. Further exploratory holes are recommended along the River Hamble valley as there is high likelihood of groundwater at surface due to the granular materials present. It is possible that a more substantial dewatering scheme and/or groundwater exclusion by sheet piles may be required.

There are a number of exploratory hole locations that did not encounter groundwater during excavation and / or drilling works including: 3K7541IT to 3K7546IT inclusive, 3K5511DS, 3K5531DS, 3K5530HP, 3K5604HP, 3K5607HP, 3K5609HP and 3K5610HP.

8.4 Flotation

There were no instances of artesian groundwater conditions above ground level during investigation.

The structures should be designed to resist flotation in all stages of temporary and permanent works.

8.5 Trenchless construction

The Applicant has confirmed details of the trenchless crossings; shaft dimensions and depths. Launch shaft dimensions will range between 9.0 m – 9.5 m diameter and reception shafts range between 5.0 m – 5.4 m diameter with a 700 mm-800 mm diameter DI pipe inserted within a 1200 mm internal diameter pipejack. Trenchless crossings are presumed to be driven west to east so the launch shafts are always the most westerly shafts. The Applicant has provided guideline depths for trenchless crossings across the project, which are generally a minimum of 2.5 m under the lowest point of the river or road crossing.

Trenchless crossings are expected to be between 9.7 m and 15 m bgl under the River Hamble, whilst beneath Wintershill at approximately 6 m and 8 m bgl. It is expected that at these depths that the tunnelling would be primarily within London Clay Formation (firm to stiff/very stiff silty clay); this is considered to be an optimum material for soft-ground tunnelling as it is generally self-supporting, of low permeability, and homogenous. Medium strong claystone bands have been encountered (e.g. at 9.70 m bgl in 2K5501SR), and may also exist at other levels, which pipejacking, will need to account for. Both open-face and closed face tunnelling methods

are likely to be suitable for London Clay Formation noting however that persistent bands of sand do also occur at various levels.

Uniaxial Compressive Strength (UCS) testing was carried out on samples from the two boreholes 2K5500SR and 2K5501SR near the proposed construction; 2K5500SR at 14.45 m bgl and 16.75 m bgl; UCS reported was 0.163 MPa and 0.129 MPa (163 kPa and 129 kPa respectively), and 2K5501SR at 9.25 m bgl and 10.9 m bgl reported was 0.180 MPa and 0.140 MPa (180 kPa and 140 kPa respectively). The tunnelling drive at the launch shaft (2K5501SR) will need to accommodate an approximate average of 14 kPa increase extra strength as shown and withstand approximately 0.10 m thick bands of medium strong claystone within London Clay Formation at 9.70 m bgl.

At borehole 3K5606SA, undrained shear strength testing of the LC between 6 – 8m bgl reported undrained strength of 240 kPa with testing at 5.2 m and 9.2 m bgl in the order of 190 – 210 kPa, a very stiff /hard clay. As 3K5605SA was not drilled during the GI period, SSP strongly recommends a cable percussion borehole be drilled at the Site of 3K5605SA prior to construction. This is to confirm the strata sequence, undrained shear strength of the London Clay between 6 – 8 m bgl, location of any hard bands, and enable the pipejack tooling to be appropriately equipped at both launch and reception shafts.

8.6 Ground Aggressivity

8.6.1 Concrete

The results of the pH and sulphate tests (SO_4) undertaken on Made Ground, Alluvium and River Terrace Deposit samples recovered indicate that the worst-case design sulphate class is DS-1 and the worst case aggressive chemical environment for concrete (ACEC) class AC-1. Head Deposits results indicated a design sulphate class of DS-2 and an ACEC class of AC-2. For London Clay Formation, the design sulphate class is DS-4 and ACEC class is AC-4. It is assumed that arisings may be oxidized when reused as fill hence the high DS class in this case.

8.6.2 Ferrous Metals

Natural soils can be aggressive towards ferrous metal.

Following guidance published by TRL (Eyre, D., & Lewis, D.A., 1987) clay is expected to prevail with the below characteristics, it is considered aggressive towards ferrous metals with:

- Characteristic apparent resistivity value of 10 Ωm
- Organic content greater than 0.2 %
- Plasticity index greater than 15
- Poorly drained area or groundwater above pipework level
- Moisture content greater than 20 %
- pH greater than 6
- Soluble sulphate 500 to 1000 mg/l
- Aggressive compounds in Made Ground (e.g. cinder or coke)

Eyre and Lewis' (1987) Contractor Report has two soil corrosivity assessment methods; Table A1 and B1. These two assessments class Section K as highly aggressive (Table A1) and very aggressive (Table B1) respectively.

8.7 Break Pressure Tank – K (BPT-K)

8.7.1 Bearing Resistance

The BPT-K comprises a twin cell tank and valve house, together with access roads on Site. Ultimate bearing resistance calculations have been completed for the tanks and valve house as described in **Section 2.2,** which at this stage is assumed to be founded on a pad foundation depth of 0.6 m bgl. bearing on London Clay Formation with removal of any softer Alluvium or made ground

Twin cell tank (21 m width x 31 m length x 4 m height)
Preliminary assessment of bearing resistance has been carried out in accordance with Eurocode 7, considering both drained and undrained cases; the undrained case is most critical. A permanent gross load of 90 kPa has been assumed for each tank (65 kPa representing 4 m from base of tank to maximum height of ceiling multiplied by a full water load of 10 kPa as 40 kPa, a 25 kPa load for wall and roof slab weight with an additional 25 kPa for a 0.6 m thick base slab). The ultimate bearing resistance, q_n is approximately 400 kPa, well in excess of the anticipated ground pressure of the structure. The full analysis output for the drained and undrained foundation bearing analysis case is attached within **Appendix J**.

Valve house (10 m length x 8 m width x 3.5 m height)
Preliminary assessment of bearing resistance has been carried out in accordance with Eurocode 7, considering both drained and undrained cases; the drained case is most critical. This shows a satisfactory pass with an overdesign factor is 7.14 in the most critical case - Design Approach 1 Combination 2. A permanent gross pressure of 20 kPa for roof, wall slab support and pipe supports has been assumed. The ultimate bearing resistance, q_n is 327 kPa, well in excess of the anticipated ground pressure of the structure. The full output is attached within **Appendix J**.

8.7.2 Settlement

Twin cell tank (21 m width x 31 m length x 4 m height)
Using a permanent load of 65 kPa, the settlement imposed is estimated to be of the order of 40 mm, assuming all alluvium and made ground is removed. It is recommended only founding on London Clay Formation and removing all alluvium where present at formation level. 40 mm is a worst-case value based on an excavation of a flat surface, but the proposed BPT-K tank location is on a steep slope. The 40mm settlement is unlikely to be fully realised because load would be attracted to the stiffer London Clay. The tank structure located at the upper end of the slope would be constructed embedded into the existing slope profile, therefore the net ground pressure imposed on this side (allowing for removal of soil) would be minimal.

Valve house (10 m length x 8 m width x 3.5 m height)
Using a permanent gross bearing pressure of 20 kPa, the settlement imposed is estimated to be of the order of 8 mm. It is recommended only founding on London Clay Formation and removing all alluvium where present at formation level. 8 mm is a worst case value based excavation on a flat surface, but the proposed valve house is on a steep slope. The 8mm settlement is unlikely to be fully realised because load would be attracted to the stiffer London Clay. The tank structure located at the upper end of the slope would be constructed becoming embedded into the existing slope profile, therefore the net ground pressure imposed on this side (allowing for removal of soil) would be minimal.

8.8 Geotechnical Hazard Assessment

Table 8.1 summarises potential geotechnical hazards associated with the Site during and post construction.

Table 8.1: Geotechnical Hazard Assessment

Hazard	Source of information/comment	Mitigation method
Unforeseen Ground Conditions	Project specific ground investigation undertaken in 2023 and 2024 to inform outline design. Trenchless bore collapse and uncontrolled ground settlement, very soft / loose material present that is inadequate for founding of pipework / chambers.	Further ground investigation is strongly recommended to confirm ground conditions at the area where 3K5605SA was originally proposed at the launch/reception shaft for the trenchless crossing at 3K5606SA southeast from Wintershill Hall and Wintershill. We would also recommend a borehole near the River Hamble and / or a hydrographic survey of the river bed to ensure the trenchless crossing is deep enough.
Groundwater	Lack of knowledge of groundwater conditions. Potentially result inappropriate/inadequate choice of dewatering techniques, excessive sump pumping causing settlement, unstable ground, inappropriate bore/trench support.	Groundwater levels are checked for boreholes during digging inspection pits (2K5502DS, 2K5503DS, 2K5534DS, 2K5535DS, 3K5513HP, 3K5515HP, 3K5529HP) and throughout post-fieldwork monthly monitoring visits.
Pit / Bore Collapse	Fracture indices within London Clay Formation during rotary coring highlighting areas of assumed zones of core loss. Inadequately defining the superficial deposits / London Clay Formation interface or from encountering sand horizons	Use vertical sided trench support: trench sheets and/or drainage if sand bands within London Clay are encountered during excavations for open cut and trenchless construction. Alternatively to prevent failure of potentially fractured slopes, cut the slopes of the trench to a shallower angle (CIRIA, 1992). Bore collapse may be mitigated by a slurry supported tunnelling bore machine (TBM).
Unknown buried structures / Southern Water assets /	Geological logs displaying strata to a maximum of 20 m bgl. Subsidence and hidden soft areas of ground previously not identified during the GI.	Ensure that proposed pipework avoids these areas of unsuitable ground and buried structures where possible. If structures are within the route alignment, arrange with the Applicant and appropriate landowners for these to be investigated/removed as early as practicable consulting all records available to the Applicant.
Excessive settlement, pipe failure / bursts.	Geological logs displaying strata to a maximum of 20m bgl. Subsidence and hidden soft areas of ground previously not identified during the GI.	Ensure that proposed pipework avoids these areas of unsuitable ground and buried structures where possible. If structures are within the route alignment, arrange with the Applicant and appropriate landowners for these to be investigated/removed as early as practicable. Other mitigation might include overdig and replace or increase pipe bedding due to poor native soil.
Existing buried services - strike, injury	Utility drawings provided to the Principal Contractor / Ground Investigation Contractor may not reveal all services underground and may differ.	Ensure that utility providers are contacted in advance of excavation works with any uncertainty proven on Site by those providers having engineers on Site. They should be in attendance where necessary such as near high risk locations. For further confirmation, Ground Penetrating Radar (GPR) and/or PAS128 surveys may also be performed.
Striking a unexploded ordnance (UXO), triggering an explosion	The Site was impacted by bombing in WWII.	Preliminary Risk Assessments were conducted specific to each exploratory hole location to reduce the section wide greater UXO risk. Zetica produced a Detailed Unexploded Ordnance Risk Assessment Report for the whole site (Zetica, 2024). Section K pipeline route has a low risk of UXO as shown in Chapter 8 of the Zetica report. Recommendations are presented within Chapter 8.1 and 8.2. For shallow intrusive works: ■ UXO Safety & Awareness Briefing
Risk of concrete degradation, failure of concrete structures.	BRE test results on Alluvium, Made Ground and River Terrace Deposits from the GI show a design sulphate class is DS1. Corresponding Aggressive Chemical Environment for Concrete (ACEC) is AC1. For Head Deposits, BRE test results show a design sulphate class is DS2. Corresponding Aggressive Chemical Environment for Concrete (ACEC) is AC2. Though DS-1 AC-1 and DS-2 AC-2 results are based on minimal testing per Section. For London Clay Formation, BRE test results show maximum available design sulphate class is DS4. Corresponding ACEC is AC4.	Ensure that additional testing is carried out for Made Ground and superficial deposits (Alluvium, Head Deposits and River Terrace Deposits) to fully categorise the design sulphate class and concrete aggressivity design sulphate class due a maximum of only 3 No. available samples of each superficial strata being tested. London Clay Formation contains high amounts of pyrite and consequently aggressive towards concrete.
Potential for chalk solution features.	Historic borehole records within 100 m of the pipeline (SU51NW2). The borehole was thought to have been drilled into a subtertiary chalk dissolution pipe (previously unknown about in 1891) at depths greater than 30 m bgl.	Undertake Electromagnetic surveying (EM) and Electric Resistivity Tomography (ERT) where any chalk is likely to be encountered underneath tertiary bedrock near where historic boreholes encountered chalk within historic London Clay soil descriptions. Evidence suggests that Chalk is at too great a depth for there to be a significant risk of chalk dissolution affecting the works.

9 Conclusions

9.1 Geotechnical

The GI data for Section K comprises many exploratory holes for the selected areas of trenchless crossings beneath the River Hamble, Wintershill Hall land, selected PSCs, non-pipeline infrastructure at BPT-K and for proving the geology along the linear route to comply with recommendations laid out in Eurocode 7: Part 2.

Shallow superficial deposits and London Clay Formation bedrock is likely to be encountered during open-cut construction, with London Clay Formation bedrock only likely to be expected during the trenchless crossing beneath the River Hamble and between Wintershill Hall land and Wintershill.

High water levels across the exploratory hole locations may require conventional sump pumping to take place. Where groundwater is likely to be expected at ground level due to potentially flooded areas adjacent to the River Hamble where high permeability gravel deposits are likely, a more substantial dewatering scheme and/or groundwater exclusion by sheet piles may be required.

Trenchless crossing construction beneath the River Hamble and Wintershill Hall area may require open face/closed face tunnelling methods, which is depending on thickness of superficial deposits and/or precise depth of bore (TBC). Pipejacking is the proposed trenchless construction technique considered by the Applicant due to passing under a number of sensitive land-uses.

Proposed open-cut construction to between 3 – 6 m bgl and trenchless construction to between approximately 9.7 – 15 m bgl are to be within London Clay Formation (as shown by the 2No 20 m boreholes adjacent to the River Hamble) and between 6 – 8 m bgl within the Wintershill area, which is heavily pyritic based on calculated Total Potential Sulphate values exceeding 2.4% suggesting a worst case design sulphate class is DS-4 and the worst case aggressive chemical environment for concrete (ACEC) class AC-4.

As a result of particle size distribution (PSD) tests and Atterberg limits analysis, Head Deposits and River Terrace Deposits may be suitable for re-use as bedding (S4), though more testing is required to confirm this – if so careful segregation of materials would be needed during construction, and perhaps some processing (e.g., to remove larger clasts). Made Ground, Alluvium and London Clay Formation are expected to be unsuitable as pipe bedding.

9.2 Geo-environmental

9.2.1 BPT-K AGP

The Phase 3B/3C GI at the BPT-K AGP location focussed on assessing ground conditions as well as investigating nearby PSC 474 – Wintershill Hall (military and civilian base). Based on the generic quantitative risk assessment the following risks were determined:

- Overall, a Moderate risk classification has been identified for impact to construction, maintenance workers and future site users; this is due to potential inhalation of ground gases.
- Risks to adjacent land users have been dismissed given that PSCs have not been identified on Site of the BPT-K AGP. Furthermore, risks to surface water bodies / watercourses and ecological receptors have been dismissed based on the absence of these receptors on the Site of the BPT-K AGP.
- Risk to future property (without mitigation) has been assessed as moderate due to potential for gas migration and accumulation. This risk rating is based on the gas risk assessment (calculated to be CS 3 – Moderate risk), whereby gas protection measures would be required in future buildings. However,

additional monitoring should be considered to better understand the ground gas regime given the inconsistent gas flow readings recorded.

- Although some PCOCs were detected in groundwater and soil leachate sampled from the BPT-K AGP location at concentrations above the GAC, risks to groundwater have been identified to be Very Low due to the underlying unproductive stratum (London Clay Formation) and absence of superficial deposits.

9.2.2 Section K DoL

Overall, based on the generic quantitative risk assessment for the Section K DoL, the following risks have been determined:

- A High risk has been identified for impact to construction workers, maintenance workers and future site users from direct contact, ingestion and inhalation of asbestos dusts and fibres within the vicinity of 2K5500SR (trenchless crossing point south of the Botely Road) due to the presence of asbestos.
- A Moderate risk rating from direct contact, ingestion and inhalation of asbestos dusts and fibres during proposed excavation works for adjacent land users has also been identified based on the presence of asbestos.
- A Moderate / Low risk has been identified for impact to construction workers, maintenance workers and future site users from inhalation of ground gases / vapours at locations investigated during the GI works.
- Risks to on Site existing and future property have been assessed as Low.
- Risks to groundwater and surface waters vary between Very Low, Moderate/Low and Moderate, depending on geology, the contaminant concentration detected in groundwater and soil leachate, and applying a conservative approach where such results are missing.
- Potential contaminant linkages to ecological receptors have been identified as Very Low risk.

Other PSCs identified within a 50 m radius of the DoL for Section K were not investigated during Phase 2 or Phase 3B/3C GI. For these areas, it was considered that the potential for the presence of significant contamination is not high as defined in the Methodology for Identification of Ground Investigation (SSP, 2022b). These may be investigated at subsequent phases of GI. Risk Assessments for these PSCs are presented in the Desk Study (SSP, 2024).

10 Recommendations

10.1 Geotechnical

Further ground investigation is recommended.
Ground investigation carried out thus far in Section K (Phase 2 and Phase 3B/3C locations) are only representative of a relatively small area of the approximate 5.1 km length of pipeline. It is recommended that further ground investigation along the route is performed to fully understand and characterise the soil required to be excavated / removed / reused at additional trenchless crossings (at the launch/reception shaft location at Wintershill where 3K5605SA was cancelled) beneath roads and rivers, PSC and open-cut areas. BRE SD1 testing is also recommended throughout soil samples taken along the route for concrete aggressivity classification.

If it is proposed to re-use materials as pipe bedding (e.g. Head Deposits and River Terrace Deposits as an S4 bedding), it is recommended that further testing (PSD, Atterberg limits, and compaction tests) is carried out to confirm suitability, and that construction monitoring includes careful segregation of materials, laboratory and in-situ testing to confirm acceptance.

If the locations that flooded and consequently terminated between 0.7 – 0.9 m bgl were revisited again to achieve greater depths (such as 6 m bgl), it would be recommended to return with Cone Penetration Testing (CPT) with MOSTAP sampling to recover environmental samples.

Resistivity test results along Section K suggest the ground conditions are highly aggressive towards ferrous metal (ductile iron), the proposed pipeline construction material. Consequently, the pipe material and surrounding pipe bedding should be designed to account for this.

10.2 Geo-environmental

Further Ground Investigation is recommended.
Groundworkers should remain vigilant throughout construction particularly within the vicinity of PSCs and should visual and/or olfactory indicators of contamination (including asbestos) be encountered, works should cease in that area and advice be sought from a suitably qualified Geo-Environmental Engineer. Further testing and specialist advice may be required. This is particularly applicable to parts of Section K to undergo open cut excavation. The additional data will inform on health and safety for construction workers and also for material management and reuse.

A return mobilisation to complete the GI at PSC 132 Infilled Ground - Pond is recommended. Although soil samples were taken, no chemical analyses have been provided by the analytical laboratory. The investigation should be timed to coincide with dryer weather conditions so that high water levels do not restrict excavation depths. These GI works could obtain further information regarding nature and extent of the Made Ground and also collect soil, soil leachate and groundwater samples.

High TPH concentrations have been detected in certain groundwater samples. The source of the TPH is unconfirmed. There is a possibility that a laboratory error has occurred that is related to the High TPH concentrations detected in groundwater and therefore to further assess potential impact to groundwater and surface waters additional GI and groundwater monitoring/sampling is recommended. Where groundwater may be encountered during the construction works, further ground investigation with groundwater monitoring and sampling should be undertaken to confirm the contaminant concentrations, ensure suitable protection of site workers and determine appropriate groundwater management and disposal routes.

There are currently no known proposals to reuse soils on Site. The reuse of material containing asbestos would not be permitted. In other areas and based on the limited soil leachate data and limited groundwater data available, further soil sampling and testing prior to construction would be necessary if material re-use is planned. This is to be determined upon further details in the design phase.

Conduct additional geo-environmental monitoring during construction.
Recommendations for ground gas and groundwater monitoring testing during the construction phase should be provided within the Construction Phase Environmental Management Plan.

BPT-K AGP – Additional Ground Gas Monitoring / Ground Gas Protection Methods
Gas risk assessment for the BPT-K AGP location calculated a Moderate risk classification (Characteristic Situation (CS) 3). According to BS8485:2015+A1:2019 (BSI, 2015a), a CS3 classification Type D building requires gas protection measures. However, given the inconsistent gas flow readings recorded at this location ranging from -19.3 l/hr to 46.3 l/hr, completing additional gas flow monitoring should be considered to further characterise the gas regime.

Watching briefs are recommended
Watching briefs should be in place during construction. Groundworkers should remain vigilant throughout construction and should visual and/or olfactory indicators of contamination (including asbestos) be encountered, works should cease in that area and advice be sought from a suitably qualified geo-environmental professional.

Stockpile management
Stockpile material must be well managed and kept on an area of hardstanding located down gradient of surface water drainage that may potentially discharge to a watercourse. It is recommended that any stockpiled material is covered to prevent rainfall infiltration, run off, and leachate and dust generation. Stockpiles should be secured when not in use to prevent third party access.

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Figures

Appendices

Appendix A: DoL for Section K Desk Study Information Specific to the GI

Tables A1.1 to A1.2 summarise desk study information specific for the Phase 2 and Phase 3B/3C GI area for Section K respectively. The standalone desk study document for the BPT-K Site is also provided below. The information was used to develop the preliminary conceptual site model (CSM) presented in the HWTWRP Geotechnical and Geo-environmental desk study Version 4 (SSP, 2024).

Table A1.1: Geo-environmental Desk Study Summary Information for Phase 2 GI Locations at Section K

		2K5500SR	2K5501SR	2K5502DS, 2K5503DS, 2K5534DS, 2K5535DS
Geology	Superficial Deposits	River Terrace Deposits	None. River Terrace Deposits approximately <5 m south; Head Deposits <10 m east	Absent
	Bedrock Geology	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)
	Artificial/Made Ground [1]	None	None	None
Hydrogeology	Bedrock Aquifer Classification	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)
	Superficial Aquifer Classification	Secondary A Aquifer (River Terrace Deposits)	N/A	N/A
	Source Protection Zones (SPZs)	None	None	Zone II
	Groundwater Abstractions [1]	None	None	Approximately 630 m southeast (potable water supply)
	Nitrate Vulnerable Zone	✓		
Hydrology	Surface Watercourses	River Hamble approximately 150 m north. A tributary to the River Hamble is 15 m southwest.	River Hamble approximately 65 m south. A tributary to the River Hamble 45 m west. A field drain may have been present > 10m of GI location.	Adjacent to drain/watercourse flowing in a south westerly direction, a tributary to Ford Lake.
	Surface Water Abstractions [1]	Approximately 490 m northeast (spray irrigation, abstraction from River Hamble. Approximately 270 m northwest (spray irrigation), abstraction from River Hamble.	Approximately 260 m southwest (spray irrigation), abstraction from River Hamble. Approximately 430 m east (spray irrigation), abstraction from River Hamble.	None
Flooding	Risk for Rivers and the sea	None		
Site History	On Site	Earliest mapping to the present day shows the investigation areas to remain as open undeveloped farmland.		Earliest mapping shows a pond/waterbody present with an unnamed watercourse/drain flowing through the pond. There is no significant change until the 1949-1972 map (NLS maps) which shows the pond no longer present (PSC 132 – Infilled Ground - Pond). The 1964 map (Groundsure, 2022) also shows the pond as no longer present.
	Surrounding Land	Earliest mapping (1840-1880s) shows the surrounding land as rural; a railway is present approximately 85 m north of 2K5500SR. Drainage channels to the River Hamble are present in the vicinity of both GI locations. The closest channel to borehole 2K5501SRwas within approximately 5 m (PSC 119) (uncil c.1957). There is little change in the surrounding area, the railway is shown as disused by the 1950s and several properties and farms are present along Botley Road. The area to the north of the River Hamble is shown as marshland.		The surrounding land remains rural with predominantly open undeveloped land (farmland) and farms since the earliest mapping.
Landfill Sites	There are no historical or current landfill Sites within 250 m of the GI locations.			
Pollution Incidents	There are no pollution incidents (category 1 or 2) within 50 m of the GI locations.			
Ecological Sensitivity (250m radius)	Sites of Special Scientific Interest (SSSIs), SSSI	None		
	Special Areas of Conservation (SAC),			
	Special Protection Areas (SPAs)			

		2K5500SR	2K5501SR	2K5502DS, 2K5503DS, 2K5534DS, 2K5535DS
	RAMSAR Site			
	National Nature Reserve (NNR)			
	Ancient Woodlands			
Preliminary Risk Assessment	Overall Risk Assessment	Potential contaminant linkages for all identified pathways and receptors were classified as Low due to the method of construction (trenchless crossing) across the River Hamble. This risk increases to Moderate/Low at the area of PSC 119 for open cut excavation.		Potential contaminant linkages (associated with PSC 132) with a high risk rating were identified for surface waters, and a moderate risk for construction workers, future Sites users and adjacent land users was identified. All other contaminant linkages were classified as low risk.

1. active groundwater and surface water abstractions within 1km; surface waters up to 250 m; artificial ground up to 250 m. All distances are approximate.

Table A1.2: Geo-environmental Desk Study Summary Information for Phase 3B/3C GI Locations at Section K

		3K5609HP, 3K5610HP, 3K5531DS, 3K5530HP, 3K5529HP	3K5607HP and 3K5608HP	3K5515HP
Geology	Superficial Deposits	None	None	None
	Bedrock Geology	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)
	Artificial/Made Ground [1]	None	None	None
Hydrogeology	Bedrock Aquifer Classification	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)
	Superficial Aquifer Classification	None	None	None
	Source Protection Zones (SPZs)	3K5610HP - Zone II The remaining holes - Zone 1	None	None
	Groundwater Abstractions [1]	Two groundwater abstractions located approximately 335 m southwest	None	None
	Nitrate Vulnerable Zone	✓		
Hydrology	Surface Watercourses	A drain is recorded approximately 5 m south of 3K5531DS. Ponds are mapped approximately 240 m east of 3K4431SDS and further ponds approximately 140 m west of 3K5609HP.	None	Unnamed tributary of the River Hamble located approximately 155 m southeast.
	Surface Water Abstractions [1]	None		
Flooding	Risk for Rivers and the sea	None		
Site History	On Site	Earliest mapping shows the area remains as open undeveloped land.	Earliest mapping to the present data shows the area as open undeveloped land.	Earliest mapping to the present day shows the area as open undeveloped land.
	Surrounding Land	Sciviers Lane has been recorded immediately southeast of 3K5610HP since the earliest available mapping (c.1888), leading north to the nearby village of Lower Upham.	Surrounding land has remained predominantly rural since the earliest available mapping (c.1888). Wintershill Hall has been recorded approximately 120 m west of 3K5607HP and 180 m southwest of 3K5608HP since 1910. This was a privately-owned stately home used during World War I as a base for the Hampshire Ambulance Service (PSC 474). During World War II, after brief use as a school, it was used as the Headquarters for the Hampshire Fire Service.	Surrounding land has remained rural since the earliest available mapping (c.1888).
Landfill Sites		There are no historical or current landfill Sites within 250 m of the GI locations.		
Pollution Incidents		There are no pollution incidents (category 1 or 2) within 50 m of the GI locations.		
Ecological Sensitivity (250m radius)	Sites of Special Scientific Interest (SSSIs), SSSI	None	Kimbers Copse is an ancient woodland located approximately 85 m southeast of 3K5607HP and 245 m southeast of 3K5608HP.	None
	Special Areas of Conservation (SAC),			
	Special Protection Areas (SPAs)			
	RAMSAR Site			
	National Nature Reserve (NNR)			
	Ancient Woodlands			
Preliminary Risk Assessment	Overall Risk Assessment	N/A – not targeting PSCs	N/A – not targeting PSCs (PSC 474 is at too great a distance to be considered further).	Potential contaminant linkages for all identified pathways and receptors were classified as Low as no PSCs were identified within the vicinity of this exploratory location.

		3K5606SA	3K5513HP	3K5604HP and 3K5511DS
Geology	Superficial Deposits	None	None	3K5511DS - Alluvium
	Bedrock Geology	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)	London Clay Formation (Clay, Silt, Sand)
	Artificial/Made Ground [1]	None	None	None
Hydrogeology	Bedrock Aquifer Classification	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)	Unproductive stratum (London Clay)
	Superficial Aquifer Classification	None	None	Secondary A
	Source Protection Zones (SPZs)	None	None	None
	Groundwater Abstractions [1]	None	None	None
	Nitrate Vulnerable Zone	✓		
Hydrology	Surface Watercourses	Unnamed tributary of the River Hamble located approximately 40 m east.	Unnamed tributary of the River Hamble located approximately 220 m north,	Unnamed drainage channel on Site of 3K5511DS and 210 m east of 3K5604HP.
	Surface Water Abstractions [1]	None		
Flooding	Risk for Rivers and the sea	None		
Site History	On Site	Earliest mapping to the present day shows the area as open undeveloped land	Earliest mapping to the present day shows the area as open undeveloped land	Earliest mapping shows the area of 3K5604HP as undeveloped land from the earliest mapping to the present day. The location of 3K5511DS is shown as undeveloped land from the earliest mapping, with potentially worked ground is showing on aerial imagery c.2019 (PSC 530 - Worked Ground – unspecified).
	Surrounding Land		The exploratory hole location is surrounded by woodland (adjacent east) and residential properties towards the south displayed in 1964 mapping.	Surrounding land has remained rural since the earliest mapping.
Landfill Sites		There are no historical or current landfill Sites within 250m of the GI locations.		
Pollution Incidents		There are no pollution incidents (category 1 or 2) within 50m of the GI locations.		
Ecological Sensitivity (250m radius)	Sites of Special Scientific Interest (SSSIs), SSSI	None		
	Special Areas of Conservation (SAC),			
	Special Protection Areas (SPAs)			
	RAMSAR Site			
	National Nature Reserve (NNR)			
	Ancient Woodlands			
Preliminary Risk Assessment	Overall Risk Assessment	N/A – not targeting PSCs	N/A – not targeting PSCs	Potential contaminant linkages for PSC 530 were assessed as Moderate/Low for all receptors, except ecology which was classified as Low.

[1]-Active groundwater and surface water abstractions within 1 km; surface waters up to 250 m; artificial ground up to 250 m. All distances are approximate.

Table A2: BPT-K Desk Study

Site Name/Reference	BPT-K
National Grid Reference (NGR)	452787E 118499N *(Based on AGP information 11 January 2024)*
Proposed Infrastructure Site	The proposed area for BPT- K AGP compound area is approximately 0.44 ha. The extended BPT-K compound area including access roads is approximately 1.8 ha. The exact location of the proposed AGP will be dependent on the route of the Proposed Underground Pipeline. This will be confirmed following hydraulic assessment of the route topography to ensure the required flow can be achieved.
Site Location and Description	BPT-K (the Site') is located at Wintershill within the private estate of Wintershill Hall. The Site may be accessed via a private road from Scivier's Lane, Durley. BPT-K is situated to the north of the main building footprint of (including Coach House Cottage) Wintershill Hall. Within BPT-K, elevations increase southwards, from approximately 65m OD in the north to 74m OD in the southeast. A Site walkover was completed in October 2023. Care should be taken when walking across the sloped area and during construction, protective track mats or boards are recommended to prevent slipping.

	 **Figure G5.1: Site location of AGP BPT-K.** (Southern Water, 2023) The Site is shown in **Figure G5.1** with the orange pipeline route to the east and north of Site.
Current Site use	Arable field (agricultural) Wintershill Hall Estate
Site History	Earliest mapping (Groundsure 2023 and 2024, NLS 2023) shows the Site as open fields (1869-1913). Mapping at this time shows the north, east and west of the Site to be surrounded by arable fields and Woolstreet copse's, with an unnamed road approximately 30m east, leading from Scivier's Lane. Wintershill House (later called Wintershill Hall) is shown approximately 45m south of the Site comprising the main house and outbuildings. Two small ponds are shown approximately 210m and 250m south of the Site respectively. Wintershill House was built in 1852 with the current gardens and parkland. In 1902, the house was renamed Wintershill Hall (Wintershill Hall, 2023). No significant changes are noted on historical mapping from the early 1900's, with exception of Woolstreet Copse to the north of the Site which is no longer shown on the 1964 map onwards. A pond approximately 245m north of the Site on the 1964 map is no longer visible on current mapping (potentially infilled) (Groundsure, 2023). Wintershill Hall was used during World War I as a base for the Hampshire Ambulance Service. During World War II, after briefly used as a school, it became the Headquarters of the Hampshire Fire Service. Information from the estate website (Wintershill Hall, 2023) states that Nissen huts were present on the lower lawn and used for offices and additional accommodation during this time. The information also states that a new sewage system was installed to cope with the additional numbers living at the estate. After the war the House was used to house orphan children rescued from concentration camps. At present, Wintershill is now being used as a residential building and venue centre (Wintershill Hall, 2023).

Geology	No superficial deposits recorded. London Clay Formation is the bedrock.
Hydrogeology	London Clay Formation (bedrock) is classified as an unproductive stratum. The Site does not lie within a groundwater Source Protection Zone (SPZ), a groundwater Drinking Water Safeguard Zone (DWSgZ) or within a groundwater Nitrate Vulnerable Zone (NVZ). One active groundwater abstraction used for potable water supply is located approximately 400m northwest. An historical groundwater abstraction (general use) was located approximately 410m northwest.
Hydrology	No watercourses are recorded on Site or within 250m of the Site. The nearest surface waterbodies (ponds) are recorded approximately 200m south within the grounds of Wintershill Hall. The Site is located within Hamble Estuary Eutrophic Nitrate Vulnerable Zone (NVZ), Eutrophic Water (ET3). Immediately south of the Site, is a Surface Water NVZ (S810) for Upper Hamble. The Site is not located within a surface water DWSgZ. There are no surface water abstractions located within 1km of the Site.
Flood Zone	The Site is located within a Flood Zone 1 (less than 1 in 1,000 annual probability of river flooding).
Environmental Setting	No Ramsar Sites, Special Areas of Conservation, Sites of Special Scientific Interest (SSSI) or Special Protection Areas are present on Site or within 250m of the Site (MAGIC, 2024).
Previous Ground Investigation/ Records of Remediation	None
Geotechnical Considerations/Issues	<u>Excavations</u> It is expected that excavation of the London Clay will be within the capabilities of conventional plant. Excavation support will be dependent upon the depth of excavation, strength of the soil and the groundwater table but where London Clay Formation comprised of firm to very stiff clay above the water table is encountered within the excavations at shallow depth (<3m) then ¼ or ½ space sheeting may be utilised or side batter in the region of 40° (CIRIA C97). <u>Foundations</u> BPT-K will be founded on the London Clay Formation. London Clay Formation may be softened slightly at the top but typically should have sufficient capacity to cope with a BPT. Ultimate bearing resistance, q_n, would be approximately 1100 kPa based on undrained conditions and assuming foundations of the BPT have a width of 10m length of 20m and constructed to 2.5m bgl. <u>Flotation/Uplift</u> Groundwater levels are currently unknown on the Site due to no previous GI data being available. GI locations are proposed in subsequent GI stages

	for this location, which would inform if any floatation (and uplift) design requirements are required. Concrete Aggressivity London Clay is noted to be pyritic throughout and are therefore likely to be moderately aggressive towards concrete.
Potential Sources of Contamination (PSCs)	**On site**: Unknown (see below **PSC 474**). **Off-Site within 50m**: Historical use of Wintershill Hall and estate grounds during World War I and II (**PSC 474**), the building footprint located approximately 35m south. Historical maps do not show the location of the Nissen huts, sensitive sites during World Wars I and II and were generally omitted from maps for security reasons. Asbestos cement sheeting has been used in construction materials of some Nissen hut styles and there may be a potential for asbestos fibres to be released to soils during demolition. It is unknown whether fuel storage or vehicle maintenance were undertaken within the estate. It is possible that if these activities were undertaken these would have been close to the main buildings. Historical maps do not provide any details to the location of these potential structures. It is unknown what activities were undertaken at the site by the Hampshire Fire Service. **Off-Site between 50m and 250m**: The small infilled Pond (**PSC 146**) located approximately 245m north is noted but is not further considered a PSC for the current BPT-K Site area due to the distance and size of the potential infilled area.
Conceptual Site Model and Land Contamination Risk Assessment	A preliminary conceptual site model (CSM) has been developed for the proposed site based on the information collated and has identified potential contaminant linkages on site and in the surrounding areas. Potential sources, pathways and receptors are listed and assessed in the land contamination risk assessment (**Table G5.1**). **Figure 12.1** shows the PSC locations. Potential contaminant linkages with a moderate/low risk rating which could potentially impact construction workers, future site users and future property (buildings and services) have been identified. A ground investigation is recommended at the proposed location BPT-K to quantify these risks.

Photograph	 **Figure G5.2: Site photograph of BPT-K infrastructure site looking northwest (Photo taken on 26/10/2023)**
Further Assessment	Further geotechnical and geo-environmental assessment is required to determine the ground conditions at the proposed BPT-K Site. These works will aid design, inform on health and safety of the construction workers and excavated materials (waste) management (i.e., disposal and/or re-use). Further details are presented in **Section 8.2.3** of the report.

The current scheme is still appraising several alternative Section routes and infrastructure sites. Revisions to the desk study including identification and confirmation of additional PSCs may i be required.

Table G5.1: Risk Assessment for construction and Maintenance Activities for PSCs within 50m and infilled land between 50m and 250m of BPT-K

Site Name/Reference	BPT-K (Section K)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (Without mitigation measures)**
Historic activities during World War I and II at Wintershill Hall and estate grounds (**PSC 474**), building footprints located approximately 35m south of proposed BPT-K location. BPT-K within grounds of Wintershill Hall. WWI: used as the base for the Hampshire Ambulance Service. Potential for storage and use of fuels. WWII: used as a school and headquarters of the Hampshire Fire Service. Potential for storage and use of fuels. Nissen huts are documented to have been present in the grounds (the exact location unconfirmed). Asbestos cement sheeting has been used in construction materials. Potential for asbestos fibres to be released to soils during demolition.	Metals, inorganics, asbestos, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and total phenols	**Construction, maintenance workers and future site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion, and inhalation of dusts.	Medium	Low Likelihood	Moderate / Low
			Inhalation of gases and vapours	Medium	Unlikely	Low
		Adjacent land users: arable farming (estate land and Farmland) residents of Wintershill Hall.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling.	Medium	Low Likelihood	Moderate / Low
		On Site future property (buildings and buried services): Location and design of building structures to be confirmed.	Direct contact with materials	Medium	Low Likelihood	Moderate / Low
			Gas migration and accumulation	Medium	Unlikely	Low
		Surface water bodies/watercourses: No main rivers within 250m.	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Mild	Unlikely	Very Low
		Groundwater: Unproductive Stratum	Leaching through unsaturated and saturated soil.	Mild	Unlikely	Very Low
		Ecological receptors (flora and fauna)	Plant uptake, direct contact, ingestion and inhalation of dusts, gases, and vapours by animals. Gases and vapours by animals.	Mild	Low Likelihood	Low

Appendix B: Chemical Analysis List of Suite and Geo-environmental Testing

Table 3.4: Summary of Geo-environmental Laboratory Tests

Analytical Suites [1]														
Sample ID	Soils								Leachates Suite 3.0 Leachate Preparation			Groundwaters	
	Suite 1.1 Made Ground	Suite 1.3 Natural	Suite 1.7 Pesticides	Suite 1.8 Herbicides	Suite 1.10 WAC	Suite 1.15 Potentially Infilled Land	Suite 2.0 Asbestos Quantification	Suite 2.15 Potentially Infilled Land	Suite 3.1 Standard leachate	Suite 3.6 Pesticide leachate	Suite 3.7 Herbicide leachate	Suite 3.1 Standard	Suite 3.9 Hydrogeology
2K5500SR 0.5 m	✓								R				
2K5500SR 1.0 m *		✓							R				
2K5500SR 4.5 m	✓C	R			xR								
2K5501SR 0.1 m	✓												
2K5501SR 1.0 m *		✓							R				
2K5501SR 6.0 m		✓							✓				
2K5503DS 0.1 m			R	R		R			R	R	R		
2K5503DS 0.3 m						R							
2K5503DS 1.0 m						R			R				
2K5500SR		N/A							✓				18/07/2023 12/09/2023 16/05/2024 30/07/2024
2K5501SR		N/A							✓				11/05/2023 08/03/2024 24/07/2023 09/04/2024
3K7542IT 0.3 m	✓												
3K7542IT 1.0 m		✓											
3K5515HP 0.2 m		✓	✓	✓									
3K5515HP 0.5 m		✓											
3K5524CT 0.2 m		✓											
3K5524CT 1.0 m		✓											

Analytical Suites [1]														
Sample ID	Soils								Leachates Suite 3.0 Leachate Preparation			Groundwaters	
	Suite 1.1 Made Ground	Suite 1.3 Natural	Suite 1.7 Pesticides	Suite 1.8 Herbicides	Suite 1.10 WAC	Suite 1.15 Potentially Infilled Land	Suite 2.0 Asbestos Quantification	Suite 2.15 Potentially Infilled Land	Suite 3.1 Standard leachate	Suite 3.6 Pesticide leachate	Suite 3.7 Herbicide leachate	Suite 3.1 Standard	Suite 3.9 Hydrogeology
3K5529HP 0.2 m		✓											
3K5529HP 1.0 m		✓											
3K5606SA 4.3 m	C	xR			✓							✓ (4.02 m- 02/12/2023), ✓ (13/01/2024- 3.95 m), ✓ (12/03/2024-6.50 m), ✓ (13/01/2024-3.96 m)	
3K5606SA 6.2 m	C	xR			✓								
3K5606SA 0.5 m	C	xR			✓								
3K5607HP 0.2 m		✓											
3K5607HP 0.5 m		✓											
3K5608HP 0.3 m		✓											
3K5608HP 1.1 m		✓											
3K5527DR 0.2 m							C						
3K5527DR 0.5 m	C	xR			✓								
3K5527DR 3.0 m		✓											
3K5527DR 8.25 m		✓											
3K5525DR 0.5 m		✓										✓ (4.97 m-13/01/2024), ✓ (5.00 m-02/12/2023), ✓ (4.00 m- 12/03/2024), R (4.81 m)	
3K5525DR 0.1 m							C						
3K5525DR 2.0 m		✓											
3K5525DR 6.8 m		✓											

Analytical Suites [1]													
Sample ID	Soils								Leachates Suite 3.0 Leachate Preparation			Groundwaters	
	Suite 1.1 Made Ground	Suite 1.3 Natural	Suite 1.7 Pesticides	Suite 1.8 Herbicides	Suite 1.10 WAC	Suite 1.15 Potentially Infilled Land	Suite 2.0 Asbestos Quantification	Suite 2.15 Potentially Infilled Land	Suite 3.1 Standard leachate	Suite 3.6 Pesticide leachate	Suite 3.7 Herbicide leachate	Suite 3.1 Standard	Suite 3.9 Hydrogeology
3K7544IT 0.1 m							✓						
3K5511DS 0.1 m	✓		✓	✓									
3K5511DS 1.0m	✓												
3K5513HP 0.5 m		✓											
3K5530HP 1.0 m								✓					
3K5531DS 0.5 m		✓											
3K5531DS 3.0 m		✓											
3K5531DS 5.3 m		✓											
3K5604HP 0.5 m		✓											
3K5609HP 1.0 m								✓					
3K5610HP 0.1 m		✓											
3K5610HP 1.0 m		✓											

[1] List of analytes included in each suite is presented in **Appendix D**.
* * no nickel analysis included in metals suite
✓ Requested and completed.
✓C completed instead of requested suite.
R Not received to date in either AGS format or Final Factual GI report (SOCOTOC, 2023)
xR Requested but completed as part of another suite of analysis.
N/A not applicable

Appendix C: Deviations Reported by Analytical Laboratory

The Quality Control (QC) associated with the results of the following soil analysis did not wholly meet the QMS requirements, therefore the accreditation has been removed by the analytical lab. However, the laboratory has confidence in the performance of the method as a whole and the integrity of the data has not been significantly compromised:

- 2K5500SR 0.5 m: TPH (C_6-C_8 aliphatic), TPH (C_7-C_8, C_{10}-C_{12} aromatic), toluene and PCB 52;
- 2K5500SR 4.5 m: TPH (C_{10}-C_{12} aromatic), MTBE and PCB 52; and
- 2K5501SR 0.1 m: TPH (C_5-C_6, C_6-C_8, C_7-C_8, aliphatic) and toluene.

Due to the matrix of the following sample the laboratory has had to deviate from standard protocols to be able to process the sample and provide a result. Where applicable the accreditation has been removed and this has been taken into consideration when utilising the data.

- 2K5501SR 0.1 m TPH (C_5-C_6, aliphatic).

Holding times have been exceeded for the following samples as stated below:

- 2K5501SR 0.1 m: BTEXHSA- (BTEX) and GRO- GRO (>C_6-C_{10}) Total and GRO CWG UK (C_5-C_{10}) Ali/Aro Split.
- 3K5511DS 0.1 m and 3K5511DS 1.0 m: KONENS- (Chloride and Hexavalent Chromium), PAHMSUS- (17 PAHs including Coronene), SFAPI- (Cyanide Complex, Free, and Total), Phenol Index (Total), Sulphide, and Thiocyanate), TOCW- (Leached Organic Carbon), and TPHFIDUS- (TPH Aliphatic, Aromatic, and SCU).
- 3K5530HP 1.00m: BTEXHSA- (BTEX).
- 3K5531DS 3.30 and 5.60 m: GROHSA- GRO (>C_6-C_{10}) Total
- 3K5531DS 0.50 m: GROHSA- GRO (>C_6-C_{10}) Total and PHSOIL- (pH)
- 3K5604HP 0.50 m: GROHSA- GRO (>C_6-C_{10}) Total and TPHFIDUS (SCU)- TPH (>C_6-C_{10}) Total with Silica Cleanup
- 3K5610HP 0.10 and 1.00 m: GROHSA- GRO (>C_6-C_{10}) Total
- 3K5515HP 0.20 m: PHSOIL- (pH)
- 3K5527DR 3.00 to 3.20 m, and 8.25 to 8.45 m: GROHSA- GRO (>C_6-C_{10}) Total and PHSOIL- (pH)
- 3K7542IT 0.30 to 0.50 m: BTEXHSA- (BTEX), GROHSA- GRO (>C_6-C_{10}) total and (C_5-C_{10}) Ali/Aro, KONENS- (Chloride and Hexavalent Chromium), PAHMSUS- (17 PAHs including Coronene), PHEHPLCUV- (Phenols), PHSOIL- (pH), SFAPI- (Phenol Index), TOCW- (Leached Organic Carbon), TPHFIDUS- (Aliphatic and Aromatic), and WSLM13- (Leached Organic Carbon, Soil Organic Matter, and Total Organic Carbon).
- 3K7542IT 1.00 m: GROHSA- GRO (>C_6-C_{10}) total and (C_5-C_{10}) Ali/Aro, PHSOIL- (pH), and TPHFIDUS (SCU)- (TPH >C_{10}-C_{40}) Total with Silica Cleanup.
- Groundwater samples 2K5501SR-4-EW-2.02, 2K5500SR-3-EW-5.04, 2K5500SR-5-EW-4.50: PHCONDW.
- Groundwater sample 2K5500SR-3-EW-50.5: GROHSA.
- Groundwaters sample 2K5500SR-5-EW-4.50: TPHCALC.

Appendix D: Geo-Environmental Laboratory Analysis Summary Screening Tables

Appendix E: HazWasteOnline™ Reports

Appendix F: Gas Monitoring Results

Table F1: Ground Gas Monitoring Results Summary for 2K5500SR

Peak Gas Concentrations (minimum for Oxygen)								
Monitoring Date	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv	Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
24 May 2023	0.3	0.1	18.1	3	1	0.2	20.9*	1024
19 June 2023	0.4	0.3	17.5	2	1	<0.1	0.4*	1023
18 July 2023	<0.1	0.1 [A]	20.3	<1	1	0.5	<0.1	1016
15 August 2023	<0.1 [B]	0.6 [B]	18.2 [B]	1 [B]	1 [B]	0.9[C]	**	1015
12 September 2023	<0.1	0.3 [A]	20.4 [A]	<1	<1	0.3	<0.1	1012
10 October 2023	<0.1	0.3 [A]	20.9 [A]	<1	<1	0.1	<0.1	1016
13 November 2023	0.6	0.6	19.8 [A]	<1	<1	<0.1	**	996
30 November 2023	2	-	17.5	4	-	0	-	998
12 December 2023	-	-	-	-	-	0.3	-	997

Peak Gas Concentrations (minimum for Oxygen)								
Monitoring Date	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv	Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
10 January 2024	0.1	0.2	21.3	-	-	<0.1	-	1025
23 January 2024	-	-	8.8	-	-	0.8	-8.6	1013
9 February 2024	-	-	-	-	-	-	-	976
7 March 2024	-	-	-	-	-	-	-	1014
4 April 2024	0.8	0.1	19.1	0	-	0.5	<0.1	1004

*Pump flow failed
**Pump flow failed after 2 minutes
CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv - Part per Million Volume
[A] Concentration as reported in the AGS.
[B] Concentration as report in Final Factual Report (SOCOTEC, 2023)
[C] Concentrations report as VOC in AGS format

Table F2: Ground Gas Monitoring Results Summary for 2K5501SR

Peak Gas Concentrations (minimum for Oxygen)								
Monitoring Date	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv	Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
09 April 2024	8.7	2.3	16.2	0	25	6.4	0	1004

CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv - Part per Million Volume

Table F3: Ground Gas Monitoring Results Summary for 3K5525DR

Peak Gas Concentrations (minimum for Oxygen)								
	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv	Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
30 November 2023	0.1	0.7	17.5	4	<1	<0.1	3.9	993
11 December 2023	<1	1.5	6.2	<1	<1	<0.1	None recorded	998
10 January 2024	0.1	1.9	1	<1	<1	0.4	-19.3	1019
23 January 2024	0.1	2.1	8.8	<1	<1	0.6	-8.6	1009
8 February 2024	0.1	2.2	9.3	<1	<1	<0.1	<0.1	986
8 March 2024	0.2	2.6	6.4	<1	<1	<0.1	-0.1	997
9 April 2024	0.1	0.3	19.3	0	<10	<0.1	46.3	995

CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv - Part per Million Volume

Table F4: Ground Gas Monitoring Results Summary for 3K5606SA

Peak Gas Concentrations (minimum for Oxygen)								
	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv	Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
30 November 2023	0.1	0.1	22.2	1	<1	<0.1	<0.1	998
11 December 2023	0.1	<0.1	21.4	3	<1	1.9	-0.1	998
10 January 2024	0.1	0.1	9.6	10	<1	1.1	-15.1	1033
23 January 2024	0.1	0.1	19.6	<1	<1	0.8	None recorded	1013
8 February 2024	0.1	0.6	19	<1	<1	<0.1	-0.2	986
8 March 2024	0.2	3.2	14.4	<1	<1	0.7	-12.7	1001
9 April 2024	<0.1	0.1	19,3	0	<10	<0.1	54.1	997

CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv - Part per Million Volume

Appendix G: Guidance for the Assessment of Land Contamination

Selection of Soil Assessment Criteria Protective of Human Health

Generic Assessment Criteria (GAC)

To evaluate potential risks to human health receptors, including future Site users, the soil analytical results have been assessed against the following Generic Assessment Criteria (GAC):

- Suitable for Use Values (S4ULs) for commercial land use (Nathanail et al, 2015) adopting a 1% soil organic matter (SOM) value.
- Lead was compared against the Defra Category 4 Screening Level (C4SL) for a commercial end use, (Defra, 2014) because a S4UL for lead has not been published, also adopting a 1% SOM value.
- Cyanide (free) was compared to the Society of Brownfield Risk Assessment (SoBRA) Acute Generic Risk Assessment criteria for assessing risks to human health from contaminants in soil (Society of Brownfield Risk Assessment (SoBRA), 2020) since there are currently no C4SLs or S4ULs for cyanide. The assessment criteria used evaluates potential for acute harm to a child by inhalation of free cyanide. This is a conservative assessment criterion used as generic assessment criteria as allows the criteria to be adjusted if the Site-specific conditions are suitable.

The GAC for a Commercial/industrial end-use have been selected as these are considered to be the most appropriate for the protection of construction workers undertaking the development and the maintenance workers who may undertake maintenance/operational work at these locations. The GAC have been generated assuming short exposure periods over a long timescale.

The GAC have been generated using assumptions regarding soil characteristics. Where the published GAC are dependent upon Soil Organic Matter (SOM), a value of 1% has been used to provide a conservative assessment. Consideration of the default soil properties used to generate the soil GAC for protection of human health is important as these influence the fate, transport and behaviour of contaminants.

- Soil type – the model default is set as Sandy Loam and assumes a dry and relatively porous soil. The default is considered sufficiently similar to the soils which are variably clayey/ sandy.
- pH – pH influences the cation exchange capacity and the portioning behaviour of a chemical between soil and water. The default is pH 7. The ground encountered have been found to have a pH of typically between 7.4 and 8.7.

Selection of Water Assessment Criteria Protective of Aquatic Eco-Systems (Controlled Waters)

Generic Assessment Criteria (GAC)

To evaluate potential risks to human health and controlled waters receptors, including the underlying Secondary A Aquifers and nearby surface water receptor such as the River Hamble and the unnamed watercourse, the leachate analysis results (2:1) and groundwater analysis results were assessed against the following:

- Environmental Quality Standards (EQS) annual average (AA) concentrations and maximum allowable concentrations (MAC) used where there is no AA.
- In the absence of a TPH threshold within the Water Supply [2](Water Quality) Regs 2021, the value of 10 µg/l as presented within the withdrawn Water Supply (Water Quality) Regs 1989 has been used for reference purposes. These thresholds are considered protective of human health.

When assessing ground condition data and the potential to harm Controlled Waters, the approach presented in Groundwater Protection Policy and Practice (GP3) (EA, 2017) has been used.

Bioavailable Environmental Quality Standards (EQS)

Bioavailable Environmental Quality Standards (EQS) have been developed for UK Specific Pollutants copper, zinc and manganese and the EU priority substances lead and nickel. An EQS is the concentration of a chemical in the environment below which there is not expected to be an adverse effect on the specific endpoint being considered, e.g., the protection of aquatic life.

The bioavailability of a metal depends on a number of physico-chemical factors which govern both metal behaviour and the interactions of the toxic forms of the metals with a biological receptor.

The EQS bioavailable corresponds to the bioavailable fraction (BioF) of dissolved metal in a sample, as determined by the physico-chemical characteristics of the water and can be calculated using a biotic ligand model (BLM) or other calculation method. To assess compliance, the bioavailable fraction of dissolved metal can be compared to the EQS bioavailable. However, bioavailable metal is not the same metric as dissolved metal as only a fraction of the dissolved metal will usually be bioavailable.

It is very difficult to measure the bioavailable concentration of a metal directly. Biotic Ligand Models (BLMs) are a predictive tool that can take account of water quality parameters such as pH, and calcium to determine the amount of bioavailable metal present. However, the complexity of the models, the runtime per sample, input data requirements and level of operator skill needed to interpret the model outputs mean that few regulatory organisations have adopted the full BLMs. The UK has developed simplified Metal Bioavailability Assessment Tool (M-BAT) for copper, zinc, nickel and manganese.

Geo-environmental laboratory analyses required to generate Site-specific Predicted No Effect Concentrations (PNEC) suitable for the protection of the identified receptors has not been undertaken. On this basis, to provide

[1] DWI (2021) Guidance on The Water Supply (Water Quality) Regulations 2016 (as amended) specific to PFOS and PFOA concentrations in drinking water DWI, January 2021.

a conservative assessment the results have been compared against the EQS for copper, zinc, manganese, lead and nickel without a correction for bioavailability.

Limit of Detection vs. Generic Assessment Criteria (GAC)

Where the concentration of a determinand is below the limits of detection and the limits of detection are below the relevant threshold criterion, the concentrations recorded are not considered to present a hazard to human health or controlled waters.

Where the concentration of a determinand is below the limit of detection and the limit of detection is greater than the relevant threshold criterion, ultra-low analysis or further Detailed Quantitative Risk Assessment would be required to robustly conclude that these can be eliminated as hazards.

Appendix H: Risk Assessment Tables

Table H1: Contaminated Land Risk Assessment for Section K

PSC 119	Infilled Land - Channel – Section K (2K5501SR)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
Infilled Channels (on Site). Made Ground with potential for infill of unknown material. Location of proposed trenchless crossing.	Potential for metals, inorganics, asbestos, petroleum hydrocarbons, PAHs, BTEX, total phenols and ground gas (methane, carbon dioxide, carbon monoxide, hydrogen sulphide). Findings of GI: ▪ No Made Ground encountered at 2K5501SR. No exceedances of GAC in soil. No asbestos detected. ▪ Exceedances the GAC for TPH, metals and PAHs (fluoranthene), total ammonia (N) and phenol in groundwater. ▪ Exceedance of the GAC for total ammonia (N) and ammonium (NH_4) in soil leachate. ▪ Ground gas monitoring recorded peak concentrations of methane at 8.7 % vol, carbon dioxide at 2.3 % vol, VOCs at 6.4 ppm and hydrogen sulphide at 25 ppm.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts.	Medium	Low Likelihood	Moderate/Low*
			Inhalation of gases and vapours	Medium	Low Likelihood	Moderate/Low*
		Adjacent land users: Farmland.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling.	Medium	Low Likelihood	Moderate/Low
		On Site existing and future property (buildings and buried services): No building structures as part of scheme.	Direct contact and gas migration / accumulation.	Medium	Unlikely No existing or future buildings proposed. Trenchless reception pit is a temporary structure	Low
		Surface water bodies/watercourses: River Hamble 65 m south. A tributary to the River Hamble 45 m west. A field drain may have been present > 10m of GI location. Temporary reception pits to be constructed	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Medium	Likely	Moderate
		Groundwater: Superficial deposits River Terrace Deposits (Secondary A Aquifer) and Alluvium (Secondary A Aquifer). Bedrock is London Clay Formation (unproductive stratum)).	Leaching through unsaturated and saturated soil.	Medium	Likely	Moderate
		Ecological receptors (flora and fauna): No statutory designated areas within 250m.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Unlikely	Very Low

* The potential for the presence of gas and the associated risks during trenchless crossing techniques will need to be evaluated and assessed in accordance with BS 6164:2019 H&S in Tunnelling in the Construction Industry - Code of Practice.

Table H2: Contaminated Land Risk Assessment for Section K

PSC 132	Infilled Land - Pond – Section K (2K5502DS, 2K5503DS, 2K5534DS and 2K5535DS)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
Former pond (potential for infill of unknown material) (on Site). Proposed route crosses the former pond.	Potential for metals, inorganics, asbestos, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene (BTEX), total phenols and ground gas (methane, carbon dioxide, hydrogen sulphide). Findings of GI: ▪ Made Ground encountered at one GI location only to 0.6 m bgl, ▪ No soil chemical data provided by the GI (lab error) but no visual/olfactory evidence of contamination. GI locations terminated at 0.9 m bgl (hand pits) due to high water table and soft ground conditions, hence due to the absence of GI data a moderate/low risk rating has been applied for construction, maintenance workers, and future site users. ▪ No installation for gas/ groundwater monitoring.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts	Medium	Low Likelihood	Moderate/Low Due to a lack of available GI data
			Inhalation of gases and vapours	Medium	Low Likelihood Due to lack of available GI data	Moderate/Low Due to a lack of available GI data
		Adjacent land users: Farmland, closest residential properties approximately 60m northeast of pipeline.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling.	Mild	Low Likelihood	Low
		On Site existing and future property (buildings and buried services): No building structures present or proposed as part of scheme.	Direct contact and gas migration/ accumulation.	Mild	Unlikely Infilled areas may be present, no existing or future buildings proposed.	Very Low
		Surface water bodies/watercourses: Drain flows in a southwest direction across the former pond area. A tributary to Ford Lake.	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Medium	Low Likelihood	Moderate/Low Due to a lack of available GI data
		Groundwater: London Clay Formation (unproductive stratum). Within a groundwater Source Protection Zone II.	Leaching through unsaturated and saturated soil.	Mild	Low Likelihood London Clay is likely to limit potential contaminant migration.	Low
		Ecological receptors (flora and fauna): No statutory designated areas within 250m.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Unlikely	Very Low

Table H3: Contaminated Land Risk Assessment for Section K

	Infilled Land – Made Ground (asbestos) – Section K (2K5500SR)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
Made Ground with potential for infill of unknown material (on Site). Location of trenchless crossing. 2K5500SR located c. 65 m south of PSCs 121, 122 and 123 (Infilled Land – Channels).	Potential for metals, inorganics, asbestos, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene (BTEX), total phenols and ground gas. Potential for ground gas from PSCs 121, 122 and 123 Findings of GI: ■ No exceedances of GAC in soil. However, asbestos cement (Chrysotile) identified in Made Ground at 2K5500SR at 0.5 m bgl at southern point of trenchless crossing (south of Botley Road). Concentration of asbestos exceeds the hazardous properties threshold. ■ Exceedances of the GAC for TPH (max. 42,200 µg/l), metals, total ammonia (N), ammonia and PAHs (fluoranthene and benzo(ghi)perylene) in groundwater. ■ Ground gas monitoring detected peak concentrations of methane at 0.6% vol, carbon dioxide at 0.6 % vol, carbon monoxide at 4 ppm and hydrogen sulphide at 1 ppm, with a minimum concentration of oxygen at 8.8% vol.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts (asbestos fibres).	Severe	Likely	High* At location where asbestos identified
			Inhalation of gases and vapours	Medium	Low Likelihood	Moderate/Low* Based on recorded concentrations
		Adjacent land users: Farmland.	Direct dermal contact, ingestion and inhalation of dusts (asbestos fibres).	Medium	Likely	Moderate At location where asbestos identified
			Inhalation of gases and vapours during excavation works and stockpiling.	Medium	Unlikely	Low
		On Site existing and future property (buildings and buried services): No building structures as part of scheme.	Direct contact and gas migration / accumulation.	Medium	Unlikely No existing or future buildings proposed. Trenchless reception pit is a temporary structure	Low
		Surface water bodies/watercourses: Trenchless crossing beneath River Hamble. Temporary reception pits to be constructed	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Medium	Likely	Moderate
		Groundwater: Superficial deposits River Terrace Deposits (Secondary A Aquifer) and Alluvium (Secondary A Aquifer). Bedrock is London Clay Formation (unproductive stratum).	Leaching through unsaturated and saturated soil.	Medium	Likely Notable TPH concentrations detected in groundwater	Moderate
		Ecological receptors (flora and fauna): No statutory designated areas within 250m.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Unlikely	Very Low

* The potential for the presence of gas and the associated risks during trenchless crossing techniques will need to be evaluated and assessed in accordance with BS 6164:2019 H&S in Tunnelling in the Construction Industry - Code of Practice.

Table H4: Contaminated Land Risk Assessment for Section K

PSC 530	Worked Ground - unspecified – Section K (3K5511DS)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
Worked Ground - unspecified (on Site). Made Ground with potential for infill of unknown material.	Potential for metals, inorganics, asbestos, petroleum hydrocarbons, PAHs, BTEX, total phenols and ground gas (methane, carbon dioxide, carbon monoxide, hydrogen sulphide). Findings of GI: ▪ Made Ground encountered to 1.6 m bgl in 3K5511DS. No exceedances of GAC in soil. No asbestos detected. ▪ No soil leachate, groundwater or ground gas monitoring data.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts.	Medium	Unlikely	Low
			Inhalation of gases and vapours	Medium	Low Likelihood No gas data available	Moderate/Low
		Adjacent land users: Farmland.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling.	Medium	Unlikely	Low
		On Site existing and future property (buildings and buried services): No building structures as part of scheme.	Direct contact and gas migration / accumulation.	Medium	Unlikely No existing or future buildings proposed	Low
		Surface water bodies/watercourses: On Site drainage channel.	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Medium	Low Likelihood	Moderate/Low
		Groundwater: Superficial deposits Alluvium (Secondary A Aquifer). Bedrock is (London Clay Formation (unproductive stratum)).	Leaching through unsaturated and saturated soil.	Medium	Low Likelihood	Moderate/Low
		Ecological receptors (flora and fauna): No statutory designated areas within 250m.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Unlikely	Very Low

Table H5: Contaminated Land Risk Assessment for Section K

PSC No. N/A	Section K (3K5606SA)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
N/A	Findings from GI: ▪ Exceedances of groundwater GAC for fluoranthene, sulphate, TPH (max. 7,210 µg/l), total ammonia (N) and ammonium (NH_4). ▪ Carbon dioxide concentrations exceed STL gas thresholds. ▪ No exceedances of GAC in soil. No soil leachate testing completed.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact (soils and groundwater), ingestion and inhalation	Medium	Unlikely	Low
			Inhalation of gases and vapours	Medium	Low Likelihood	Moderate/Low
		Adjacent land users: Farmland, closest residential properties approximately 60 m northeast of DoL.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling.	Medium	Unlikely	Low
		On Site existing and future property (buildings and buried services): No building structures as part of scheme.	Direct contact	Medium	Unlikely	Low
		Surface water bodies/watercourses: Unnamed tributary of the River Hamble located approximately 40 m east.	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	Medium	Low Likelihood (Potential risk of run-off. Although high TPH concentration detected in groundwater, London Clay is likely to limit potential contaminant migration to surface water).	Moderate / Low
		Groundwater: Bedrock is London Clay Formation (unproductive stratum).	Leaching through unsaturated and saturated soil.	Mild	Unlikely (London Clay will limit migration)	Very Low
		Ecological receptors (flora and fauna): No statutory designated areas within 250m.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Unlikely	Very Low

Table H6: Contaminated Land Risk Assessment for BPT-K AGP within Section K

PSC 474	Wintershill Hall (former military/civilian base) - Section K (3K5521CT, 3K5540CT, 3K5541CT, 3K5525DR and 3K5527DR)					
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (without mitigation measures)**
Wintershill Hall (military/civilian base) located approximately 35 m south of BPT-K.	Potential for metals, inorganics, asbestos, petroleum hydrocarbons, PAHs, volatile organic compounds (VOCs) and total phenols. Findings of GI: ▪ No exceedances of GAC in soil. No asbestos detected. ▪ Exceedances of GAC for TPH and chloride in groundwater (3K5525DR). ▪ Exceedance of the GAC for phenol in soil leachate (3K5525DR). ▪ Ground gas detected coupled with high flow rates. The GSV for 3K5525DR corresponds to a moderate risk (CS3) whereby gas protection measures would be required for new buildings. The gas source detected during GI may not be attributable to PSC 474.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts	Medium	Unlikely	Low
			Inhalation of gases and vapours	Severe	Low likelihood	Moderate
		Adjacent land users: arable farming	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works and stockpiling	N/A for PSCs outside BPT-K		
		On Site existing and future property (buildings and buried services): AGP BPT-K	Direct contact and gas migration/ accumulation	Medium	Unlikely	Low
			Gas migration and accumulation	Severe	Low likelihood	Moderate
		Surface water bodies/watercourses: None within 250 m	Surface water runoff from stockpiles and migration through groundwater and underground utilities.	N/A for a PSC outside BPT-K		
		Groundwater: London Clay Formation (unproductive stratum).	Leaching through unsaturated and saturated soil.	Mild	Unlikely London Clay is likely to limit potential contaminant migration.	Very Low
		Ecological receptors (flora and fauna): Kimbers Copse, an ancient woodland c.185 m southeast.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	N/A for a PSC outside BPT-K		

Appendix I: Risk Assessment Methodology

Appendix J: Bearing Resistance and Settlement at BPT-K